PROCEEDINGS OF THE

Twenty-Fourth Annual Convention

OF THE

American Railway Bridge and Building Association

HELD AT

LOS ANGELES, CAL.

October 20-22, 1914

REPORTS IN THIS ISSUE

Ice Houses
Warnings (Bridges, etc.)
Reinforced Concrete Bridge Work
Mechanical Coaling Stations
Street Crossing Elimination
Water Supply (Pipe Lines)
Concrete Posts, Poles and Signs

INDEX ON PAGE THREE

PUBLISHED BY THE ASSOCIATION
C. A. Lichty, Secretary
319 NO. WALLER AVENUE
CHICAGO, ILL.

Twenty-Fifth

Annual Convention

Detroit, Mich.

October 19-21, 1915

LOVELL D. HADWEN
President, 1914-15

PROCEEDINGS OF THE

Twenty-Fourth Annual Convention

OF THE

American Railway Bridge and Building Association

Successor to the

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS

HELD AT

LOS ANGELES, CAL.

OCTOBER 20-22, 1914

Official Badge

PRICE, ONE DOLLAR

BRETHREN PUBLISHING HOUSE
ELGIN, ILLINOIS
1914

TABLE OF CONTENTS

COMMITTEE REPORTS

OFFICERS FOR 1914-15

L. D. HADWEN, ...President
Chicago, Milwaukee & St. Paul Ry., Chicago, Ill.

G. ALDRICH, ...First Vice-President
New York, New Haven & Hartford R. R., Boston, Mass.

G. W. REAR, ...Second Vice-President
Southern Pacific Co., San Francisco, Cal.

C. E. SMITH, ...Third Vice-President
Missouri Pacific Ry., St. Louis, Mo.

E. B. ASHBY, ...Fourth Vice-President
Lehigh Valley R. R., New York City.

C. A. LICHTY, ...Secretary
Chicago & Northwestern Ry., Chicago, Ill.

F. E. WEISE, ...Treasurer
Chicago, Milwaukee & St. Paul Ry., Chicago, Ill.

S. F. PATTERSON, Secretary Emeritus, ...Concord, N. H.

THE EXECUTIVE COMMITTEE

Consists of the Officers and the Following Members:

W. F. STEFFENS, New York Central Lines, ...New York City
S. C. TANNER, Baltimore & Ohio R. R., ...Baltimore, Md.
LEE JUTTON, Chicago & Northwestern Railway, ...Madison, Wis.
W. F. STROUSE, Baltimore & Ohio R. R., ...Baltimore, Md.
C. R. KNOWLES, Illinois Central R. R., ...Chicago, Ill.
ARTHUR RIDGWAY, Denver & Rio Grande R. R., ...Denver, Colo.

PAST PRESIDENTS

1891-92	*O. J. Travis,	Pinehurst, Wash.
1892-93	*H. M. Hall,	Ohio & Mississippi Ry., Olney, Ill.
1893-94	*J. E. Wallace,	Wabash R. R., Springfield, Ill.
1894-95	G. W. Andrews,	Baltimore, Md.
1895-96	W. A. McGonagle,	D. M. & N. Ry., Duluth, Minn.
1896-97	James Stannard,	Kansas City, Mo.
1897-98	*Walter G. Berg,	Lehigh Valley R. R., New York City
1898-99	J. H. Cummin,	Bay Shore, N. Y.
1899-00	A. S. Markley,	Chicago & Eastern Illinois R. R., Danville, Ill.
1900-01	W. A. Rogers,	37 W. Van Buren St., Chicago, Ill.
1901-02	W. S. Danes,	Wabash R. R., Peru, Ind.
1902-03	B. F. Pickering,	Boston & Maine R. R., Salem, Mass.
1903-04	A. Montzheimer,	Elgin, Joliet & Eastern Ry., Joliet, Ill.
1904-05	C. A. Lichty,	Chicago & Northwestern Ry., Chicago, Ill.
1905-06	J. B. Sheldon,	N. Y. N. H. & H. R. R., Providence, R. I.
1906-07	J. H. Markley,	Toledo, Peoria & Western Ry., Peoria, Ill.
1907-08	R. H. Reid,	L. S. & M. S. Ry., Cleveland, O.
1908-09	J. P. Canty,	Boston & Maine R. R., Fitchburg, Mass.
1909-10	J. S. Lemond,	Southern Ry., Charlotte, N. C.
1910-11	H. Rettinghouse,	C. St. P. M. & O. Ry., St. Paul, Minn.
1911-12	F. E. Schall,	Lehigh Valley R. R., So. Bethlehem, Pa.
1912-13	A. E. Killam,	Moncton, N. B.
1913-14	J. N. Penwell,	L. E. & W. R. R., Tipton, Ind.

*Deceased.

SUBJECTS AND COMMITTEE APPOINTMENTS FOR 1915

1. Use of Locomotive Cranes.

G. W. Rear, Chairman, Sou. Pac. Co., San Francisco, Cal.
A. T. Mercier, Sou. Pac. Co., Los Angeles, Cal.
D. E. Plank, Pac. Elec. Co., Los Angeles, Cal.
D. A. Shope, A. T. & S. F. Ry., Fresno, Cal.
W. O. Eggleston, Erie R. R., Huntington, Ind.
E. T. Howson, Railway Age Gazette, Chicago, Ill.
G. H. Stewart, B. R. & P. Ry., East Salamanca, N. Y.
E. B. Ashby, L. V. R. R., New York City.

2. Pile and Timber Trestle Bridges.

A. B. McVay, Chairman, L. & N. Ry., Evansville, Ind.
C. E. Smith, Mo. Pac. Ry., St. Louis, Mo.
F. G. Jonah, St. L. & S. F. Ry., St. Louis, Mo.
S. T. Corey, C. R. I. & P. Ry., Chicago, Ill.
J. J. Taylor, K. C. S. Ry., Texarkana, Texas.
E. J. Auge, C. M. & St. P. Ry., Wells, Minn.
A. J. James, A. T. & S. F. Ry., Topeka, Kans.
S. C. Tanner, B. & O. R. R., Baltimore, Md.

3. Railway Water Tanks.

C. R. Knowles, Chairman, I. C. R. R., Chicago, Ill.
A. A. Wolf, C. M. & St. P. Ry., Milwaukee, Wis.
O. M. Suter, I. C. R. R., Chicago, Ill.
T. J. Stuart, W. Pac. Ry., Elko, Nev.
Jas. Dupree, C. T. H. & S. E. Ry., Crete, Ill.
A. C. Sydell, C. B. & Q. R. R., Chicago, Ill.
F. M. Case, C. & N. W. Ry., Belle Plaine, Iowa.

4. Small Coaling Stations.

Lee Jutton, Chairman, C. & N. W. Ry., Madison, Wis.
W. T. Krausch, C. B. & Q. R. R., Chicago, Ill.
G. Aldrich, N. Y. N. H. & H. R. R., Boston, Mass.
B. F. Pickering, B. & M. R. R., Salem, Mass.
A. W. Pauba, C. & S. Ry., Denver, Colo.
J. L. Talbott, A. T. & S. F. Ry., Pueblo, Colo.
G. A. Manthey, Soo Line, Minneapolis, Minn.
Wm. Mahan, W. & L. E. Ry., Canton, Ohio.

5. Costs of Structures.

G. A. Rodman, Chairman, N. Y. N. H. & H. R. R., New Haven, Conn.
F. E. Weise, C. M. & St. P. Ry., Chicago, Ill.
J. H. Nuelle, N. Y. O. & W. Ry., Middletown, N. Y.
J. S. Robinson, C. & N. W. Ry., Chicago, Ill.
R. C. Sattley, C. R. I. & P. Ry., Chicago, Ill.
C. W. Wright, Long Island R. R., Jamaica, N. Y.
W. A. Pettis, N. Y. C. Lines, Rochester, N. Y.

6. Efficient Methods of Handling Work and Men.

G. W. Rear, Chairman, Sou. Pac. Co., San Francisco, Cal.
J. F. Pinson, C. M. & St. P. Ry., Seattle, Wash.
E. R. Wenner, Lehigh Valley R. R., Ashley, Pa.
C. R. Knowles, I. C. R. R., Chicago, Ill.
R. H. Reid, L. S. & M. S. Ry., Cleveland, Ohio.
H. A. Horning, M. C. R. R., Jackson, Mich.
S. C. Tanner, B. & O. R. R., Baltimore, Md.

7. Warnings for Overhead and Side Obstructions.

E. G. Storck, Chairman, P. & R. Ry., Philadelphia, Pa.
M. M. Barton, P. R. R., West Philadelphia, Pa.
F. E. Schall, Lehigh Valley R. R., South Bethlehem, Pa.
T. E. Thomas, B. & O. R. R., Wilmington, Del.
E. S. Meloy, C. M. & St. P. Ry., Chicago, Ill.

8. Reinforced Concrete Bridge Work.

O. F. Dalstrom, Chairman, C. & N. W. Ry., Chicago, Ill.
I. L. Simmons, C. R. I. & P. Ry., Chicago, Ill.
J. A. Bohland, G. N. Ry., St. Paul, Minn.
C. J. Scribner, C. B. & Q. R. R., Chicago, Ill.
D. C. Zook, Pennsylvania Lines West, Ft. Wayne, Ind.
T. J. Stuart, W. P. Ry., Elko, Nev.

9. Station Buildings for Passenger Service Only.

M. A. Long, Chairman, B. & O. R. R., Baltimore, Md.
E. B. Ashby, Lehigh Valley R. R., New York City.
G. W. Andrews, B. & O. R. R., Baltimore, Md.
K. Peabody, New York Central Lines, Rochester, N. Y.
R. McKibben, P. R. R., Altoona, Pa.
W. T. Krausch, C. B. & Q. R. R., Chicago, Ill.

10. Concrete Culvert Pipe and Concrete Piles.

H. Rettinghouse, Chairman, C. St. P. M. & O. Ry., St. Paul, Minn.
S. T. Corey, C. R. I. & P. Ry., Chicago, Ill.
G. H. Stewart, B. R. & P. Ry., East Salamanca, N. Y.
C. F. Urbutt, C. M. & St. P. Ry., Chicago, Ill.

11. Street Crossing Gates, Towers, Bells, etc.

E. C. Morrison, Chairman, S. P. Co., San Francisco, Cal.
J. B. Gaut, G. T. R., M. L. & T. Bldg., Chicago.
J. H. Johnston, G. T. R., Montreal, Que.
C. E. Johnston, K. C. S. Ry., Kansas City, Mo.
J. B. Sheldon, N. Y. N. H. & H. R., Providence, R. I.
G. H. Jennings, E. J. & E. Ry., Joliet, Ill.
A. Ridgway, D. & R. G. R. R., Denver, Colo.
F. O. Draper, I. C. R. R., Chicago.
A. T. Mercier, S. P. Co., Los Angeles, Cal.
F. M. Nelson, S. P. Co., San Francisco, Cal.

NOMINATIONS.

R. H. Reid, L. S. & M. S. Ry., Cleveland, Ohio.
S. F. Patterson, Concord, N. H.
J. N. Penwell, L. E. & W. R. R., Tipton, Ind.
J. P. Canty, B. & M. R. R., Fitchburg, Mass.
F. E. Schall, L. V. R. R., South Bethlehem, Pa.

SUBJECTS.

F. E. Weise, C. M. & St. P. Ry., Chicago, Ill.
C. E. Smith, Mo. Pac. Ry., St. Louis, Mo.
E. C. Morrison, Sou. Pac. Co., San Francisco, Cal.
G. Aldrich, N. Y., N. H. & H. R. R., Boston, Mass.

RELIEF.

A. Montzheimer, E. J. & E. Ry., Joliet, Ill.

MEMBERSHIP.

H. A. Horning, M. C. R. R., Jackson, Mich.
J. A. Bohland, G. N. Ry., St. Paul, Minn.
G. A. Rodman, N. Y., N. H. & H. R. R., New Haven, Conn.
I. O. Walker, N. C. & St. L. Ry., Paducah, Ky.

PUBLICATIONS.

J. S. Robinson, C. & N. W. Ry., Chicago, Ill.
E. S. Meloy, C. M. & St. P. Ry., Chicago, Ill.
R. C. Sattley, C. R. I. & P. Ry., Chicago, Ill.

ARRANGEMENTS.

J. P. Wood, P. M. R. R., Saginaw, Mich.
P. J. O'Neill, L. S. & M. S. Ry., Adrian, Mich.
S. D. Bailey, M. C. R. R., Detroit, Mich.
F. P. Sisson, G. T. R., Detroit, Mich.

OBITUARY.

B. F. Pickering, B. & M. R. R., Salem, Mass.

Proceedings of the Twenty-fourth Annual Convention

of the

American Railway Bridge and Building Association

Held in the Hotel Alexandria

Los Angeles, Cal., October 20-22, 1914

MORNING SESSION.

Tuesday, Oct. 20, 1914.

The twenty-fourth annual convention was called to order at 10 A. M. by President J. N. Penwell.

Prayer was offered by Rev. Charles Edward Locke.

The President:—I am pleased to announce that we are to have the privilege of listening to a few remarks from Mr. H. V. Platt, assistant general manager of the Southern Pacific.

Mr. Platt:—Mr. President, ladies, and fellow bridgemen. I suppose that everybody here will think I am a bridgeman. In the first place, Mr. President, I feel that I owe this convention, and especially the committee, an apology. About six weeks ago, I was requested to prepare an address of welcome to this convention, which task, I assure you, I was very pleased to undertake. In the meantime, like you gentlemen here, I fell heir to a vacation; and, likewise, on my return home, I fell heir to a great deal of work; also on the 15th of this month, the quail season opened. After returning from Catalina, last evening, I picked up a paper and saw that the bridgemen of America were to open their convention here today; and I was at once reminded that I had accepted the obligation of making an address of welcome.

I have nothing prepared, and what I shall say to you will, in a measure, have to be made up for by the earnestness with which we shall endeavor to make you welcome to Los Angeles and South-

ern California. There is perhaps no place on earth that has the name of being more hospitable than Los Angeles and southern California. We are prepared here, by reason of what nature has done for this section of the country, to make a visit to this place one long to be remembered by all who may be favored with the opportunity to come; and it will be my pleasure, as a representative of the Southern Pacific Company, to hang the latch string on the outside of the door while this convention is in session, and afterward, until such time as each and all of you have returned to your respective homes and to your work. On behalf of the great company which I have the honor to represent, I want to extend to you a cordial invitation to call either at my office or on Mr. Whalen, our local superintendent, or on any of our local bridgemen, for any courtesy or any favor, that may add to your pleasure while you are here.

In glancing over the papers last evening, I noted a number of the subjects which are to come before this convention, and I was at once reminded of the responsibility that is placed upon the deliberations of a convention of this kind. By reason of your craft, you gentlemen are peculiarly a body of men who set about to do things, to create things; and, above all, to keep things safe, after they have been made and created.

I want to pay a particular tribute to the bridgeman as a craftsman. I say this, gentlemen, after about 28 years of actual experience. In times of stress and trouble any man in an official capacity feels safer when the word is passed to him that a bridgeman is on the job. In times of storms and washouts, there is one man on whom we rely to tell us when we shall pass the locomotive over the structure; and when that man gives the word we do not hesitate, because we know he has figured the stress; perhaps not with pencil and paper, but through a system born of experience that enables him to tell when looking at a structure just what that structure is calculated to carry. We rely on men who know, and we are proud to have a convention of men assembled in our midst who are creators of things; who are constantly striving for the betterment of things that make travel safe in these United States, and in fact all over the world.

I am reminded of the story of the faithful colored servant, who, after a long period of service, was granted a leave of absence. His master asked him which he would prefer, a trip on the railroad or a trip on the ocean. The old servant thought for awhile,

and then said, "I will give you my answer tomorrow." The next day, he said he had decided to take a trip on the railroad. His master was somewhat interested, and asked why. "Well," he said, "If you are on the ocean and anything goes wrong, there is no ground under you, nothing but water, but, if anything happens on the railroad you are on the ground, and there you are."

It is up to you, gentlemen, to bridge over the places where there isn't anything underneath, and that is exactly what you are doing in a way that makes the railroad fraternity rely upon you as silent sentinels, always on guard at the weakest point; or protecting the weakest link of our transportation plant, the section of our road bed which is above the ground.

I again want to impress upon you bridgemen how much the management of a railroad relies upon you. When the word is passed, in case of trouble, to the superintendent on the other end of the phone that such and such a foreman is in charge at that particular point, I want you to realize—and it is the highest tribute I can pay you—what a degree of satisfaction it is to the superintendent of a division, and to those in higher authority. Gentlemen, I can do no better than to pay you this tribute in all seriousness, and to salute you.

The President:—It gives me pleasure to introduce to you, ladies and gentlemen, Mr. W. H. Whalen, superintendent of the Los Angeles division of the Southern Pacific, who is now to address us.

Mr. Whalen:—Mr. President, Ladies, and I too can say fellow bridgemen, I too bid you a most hearty welcome to our California. I want to say that, in choosing this place for your convention, you have manifested that which is the greatest requirement in a bridgeman, good judgment—you selected the best. There is, in my estimation, no place you could go where you could be more free from care, where you could see nature perspiring to help you out, and where you could have such endeavors made to help you in your work.

I am very glad, indeed, to welcome the ladies—to see so many of them here. We are learning as we go on in this matter of conducting transportation—no matter in what branch of the service we are engaged—that the ladies are needed. To bring the matter more closely to your attention, I am going to tell you a little story on a locomotive engineer. He and his wife were in Cleveland, Ohio, on a vacation. They went to the wharf and saw a big

freighter. The engineer said to his wife, "Can you draw on your imagination and see how emblematic of man that boat is?" She said, "What do you mean?" He said, "I am not speaking of it as a boat at all, but he is coming in there unpretentiously to release his cargo." The man comes in after his work—they are both working to one end, common welfare. She said, "All right." About that time, the boat swung around. On the other side of the boat there was to be seen a little tug, and she said, "Can you draw on your imagination and see how emblematic of woman that tug is? As to the outline of form and beauty there is no comparison, but the big fellow you see to the right, there, needs the tug to put him up against the work." So it is with you ladies: the big fellow needs you to put him up against the work; there is no question about that.

Now, in welcoming you, I spoke of great California. I am going to tell you why it is great. I am simply continuing the truth as stated by our assistant general manager. On this division, which is but a small spot in Southern California, we produced and sent to the market, 5,048 carloads in 43 days. In the Imperial valley at the present time there are about 50,000 bales of cotton ready to go out. During the course of a year, there is almost enough stock raised in the Imperial valley to feed the people of the entire state of California. Not far from Los Angeles, in the smallest district, there are harvested 46,000 carloads of oranges and lemons. There are harvested and sent east in the course of a year, 1,400 carloads of celery. There were 510 carloads of walnuts sent out last year, and we are completing a harvest this year which will equal that of last year. From 38,048 carloads of sugar beets we made 3,000 carloads of sugar last year. We harvested 1,800 carloads of beans, and so on. I could continue indefinitely with these figures as they pertain to our division, which, as I said before represents but a small part of southern California. This is why I consider it great—why I consider myself privileged to say to you, "great Calfornia."

I think if you will take the advice of Mr. Platt, and stay over a few days, following your deliberations, you will decide you want to come back. Other people who came out got the "bug" and came back. I want you folks to do the same. I do not know of any class of people in the world who could so act in harmony with us, work in harmony with us, and work to the standard of southern California as could the bridge and building people.

I wish you gentlemen knew about building bridges what I do not know. I can say to you, however, that I had considerable experience last year in spanning that which was caused by the storm. We did not stop to build bridges. We did the next thing,—we built as Robinson Crusoe did, and used the available material.

I might tell another little story by way of illustrating what you people have to do, and what we did up in Wisconsin. There was a man who had worked for some time in Antigo. Being thrifty he thought he would go into business for himself, but he did not have the equipment necessary to carry on the work as he had in the old institution. On one occasion it was necessary for him to use some glue. He sent Mike to the basement for it. Mike was gone some time. When Mike returned the man said, "Mike, never mind, I used some clay." So it is with you bridgemen. You are the class that has to overcome obstacles; you must avail yourselves of the elements. You are of the class that can not use any shoddy on your work, because after you give it to us to operate, it is put to that physical test that determines the value of your work. For that reason, you of all men working for a railroad company, can least afford to do that which is shoddy.

I will become somewhat reminiscent for a moment. A man by the name of Crane was our superintendent of bridges and buildings on the North Western at Janesville, Wis., in the old days. He was one of the old school. He had a son, George. This son was not of the old material at all, but Mr. Crane was trying his best to make a bridgeman out of him, and on one occasion started him over the road with Bert Sampson on bridge inspection with a motor car. They forgot that anyone else was on the road, and they went over an embankment while the car was a total wreck. George came in after several days. "Sit down," said his father, "and tell me how it happened." "Well, father," he said, "I'll tell you: suppose— " "But," said his father, "you must not 'suppose' in railroading, you must 'know.'" We must not suppose, we must know. You are of the class of people who must know.

I see considerable work ahead for all of us in the matter of bridge building. There has been a chasm caused, not by the storms of the Heavens, but by the storms of the law; the storms of agitation; the storms of the demagogue—of the practical politician. It is a chasm between the two interested parties in this matter of transportation—the purchaser of transportation and the people who sell the transportation—the railroads. You will all agree with me

when I say that there is today a chasm between the two, and that it is for common good that we must arise in our way and exert our best efforts to span the chasm. I am referring to the distrust between the man who buys the transportation and he who sells it. That is the chasm I think we have to span, and I believe this is the proper time and opportunity to speak of it. I would recommend that the foundations of the bridge which is to span this chasm between the buyer and seller of transportation be built with rocks of common sense, cemented with a concrete of co-operation. The superstructure, I would make of square dealing. We do not necessarily have to be bridge builders, nor do we have to be locomotive engineers or division superintendents to enter into the spirit of this work. It is a matter that is worthy of our endeavors and resolutions to try to head the matter in the right direction.

There is a matter that I want to suggest for your deliberation. I learned by experience last Spring that a pile structure no longer belongs in the waterway in such a country as ours, where floods are liable to occur. In our country the erosion is something wonderful. We at first thought that such bridges were all right, but we have realized that this class of structure is impracticable. I say that this subject is worthy of your consideration.

President Penwell:—Mr. L. D. Hadwen, of the C. M. & St. P., will respond to these addresses of welcome on behalf of the association.

Mr. Hadwen:—Mr. President, fellow members, Mr. Platt and Mr. Whalen. I feel somewhat in the same position as did Mr. Whalen, except that I am worse off. Our secretary came to me ten minutes before I entered the room and said, "We would like to have you respond to the opening address." I know that we have a great deal of eloquence that comes from Boston and other centers, and I had hoped that someone from one of these localities would be allowed to fill this position. We also have one of our past presidents here, who should have stepped in; but he has left me in the lurch. I know that many of you here will recall the witty remarks of Mr. Rettinghouse on occasions of this kind in the past, and I want to take this opportunity to rub it into the gentlemen for picking me as a victim at the last moment.

We are all almost overwhelmed with the excess of hospitality we are receiving here. I know that the phrase, "Southern hospitality," is frequently used. We can now amend that phrase by adding, "Southern Pacific, Santa Fe and California hospitality."

I feel something like some of the allies: I have to come up with small caliber guns against the big siege guns the Germans are putting forward; and, not satisfied with having me respond to Mr. Platt, they bring on a 16 caliber gun (Whalen) to bombard me. I think we all feel inspired by the eloquent tribute paid to our calling by Mr. Whalen, and it will be a reminder to us, of our responsibility if we need any. I think Mr. Whalen also voiced a sentiment that we all feel, that we should all take heart and do our part in familiarizing the public with some of the reasons why the railroads are entitled to a hearing as well as the people who use them.

I would never have been able to get up here and make these few remarks, for it is a maiden effort for me, but, with nearly 100 of our party, I have been through a little Harveyizing process. We have been Harveyized by the hospitality of the Santa Fe all the way out. Consequently, my resistance is a little better than it might have been.

I don't think I can mention anything further except that Brother Rear, who has been working to get the convention to come out to this delightful country, has met with some resistance in the past, because many of the members thought it would be difficult to get an adequate representation out on this western Coast; but by the number of members present, I judge this will be the best attended meeting we have had at any convention; and may be that because of the hospitality we have received we will all want to come back. I am sure that we all appreciate this open, wide-armed welcome we have received.

PRESIDENT'S ADDRESS.

Ladies and Gentlemen: It is with pleasure that I greet you this morning in this beautiful city in the Golden State; one we have long desired to visit on account of its fame throughout the world; for its health, it beauty, and the hospitality of its people. We are here for a two-fold purpose, first, for business representing 251,000 miles of railroad throughout the country, and next for pleasure and recreation. We have at present 559 members with a number of applications to be voted upon today.

This Association was organized in St. Louis 23 years ago and it is with extreme pleasure that I announce to you that two of its Charter Members are with us today; I refer to Mr. A. S. Markley and Mr. G. E. Hanks. Our Association has been unique in some respects. I dare say none of our railroad associations have represented their interest in the railroad in a more commendable way. The moral tone of our Association has always been good, and has been commented upon by the city officials in many cities. We can well be proud of this record.

I would remind you, gentlemen, that we are here first for business

and it is the duty of every member to do all he can in this convention. He has practical ideas that other men want and I dare say he needs the new thoughts to be gathered from other men as well. We should be as willing to give out information and practical ideas as we are to receive them, and we should receive enough while here to pay our railroad companies for sending us as their representatives.

Our Association is not a technical one, although some of our reports necessarily take up technical points, but our aim and business is to work out the most practical ideas and means of handling the work designed by bridge engineers, chief engineers, and architects. We should, therefore, endeavor to coöperate with the American Railway Engineering Association and with the American Railway Association, as the three are closely connected.

The last year has been one of uncertainty with many of us, because of financial conditions which have held up so much important work. Most of us have been called upon to economize to such an extent that our mental work has been heavy, and while we have not handled the volume of work, it has not been an easy year.

You are justly entitled to a little recreation and pleasure, which you will be permitted to take part in when our business sessions are over, but keep in mind that business comes first. We will then meet with some surprises as the railways and the people of Los Angeles, as well as the people of the entire Golden State are broad minded and want you to enjoy your visit.

I might speak of statistics, but these, as a rule, are not very interesting for an audience, and our minds should be centered around the reports to be presented to this convention, as our proceedings go into the hands of higher railway officials as well as technical schools, universities, State libraries, and Government buildings.

I would like to say to the new members that we want you to feel free to enter into the work the same as the older members. You may have some thought in mind that will be of value to our reports. Besides, the way to enjoy anything of importance is to enter into the spirit of it. The coöperation of our members is necessary to success in this the same as in any other movement for the advancement of railroad work and interests.

Observing the number of ladies in this room, and knowing their worth to the busy man, I cannot close without an attempt, at least, to say a few words to them. You ladies who have met with us year after year and graced the dignity of our association can hardly realize how much you add to the moral tone of our conventions. Your presence is an honor to us and a safeguard to our association. To those who are attending for the first time I wish to say you have joined a happy family and must not expect any formality. Real pleasure goes first and we want you to feel free. I said we appreciate your presence—we ought to. When man is discouraged and the world seems dark, when burdens are heavy, when everything seems to have gone wrong, a woman's love is to a man's heart what a fountain is to a desert land. Her love will find a star to light his pathway and change his thoughts from sorrow to joy, guiding him from failure to success. She has shared his joys and sorrows without complaint and her smiles of approval have brought out his better nature and led him on to success. I speak advisedly because I have in mind the first lady of this association who has passed away. I have learned from her sweet influence not to be afraid to trust you with man's best interests and believe in you as the safeguard of a man's life. Neither am I afraid to let you vote, and when America wakes up to its opportunities the vote of an intelligent American woman will correct some conditions brought about by the vote of the uneducated foreigner not wanted even in his own country. Come again and help us make life worth living.

Remember, gentlemen, those who work best, can play best. Stick to the sessions and be in good trim for the pleasures to follow.

The President:—We will now have a short recess to allow the ladies to retire from the hall after which we will resume the regular order of business.

(Short recess.)

The President:—The first order of business is that of roll call. It has been customary for several years past to secure the names of those present by the registration system. Cards will be distributed for that purpose.

According to the registration the following members were in attendance:

G. Aldrich,
R. J. Arey,
E. K. Barrett,
A. H. Beard,
R. W. Beeson,
J. S. Berry,
J. M. Bibb,
Stanton Bowers,
T. W. Bratten,
Alf. Brown,
J. B. Browne,
R. J. Bruce,
H. Bulger,
W. H. Burgess,
Daniel Burke,
J. T. Caldwell,
F. M. Case,
W. S. Corbin,
D. M. Crosman,
Geo. Dickson,
I. A. Draper,
Jas. Dupree,
W. E. Elder,
B. F. Ferris,
M. Fisher,
A. Fraser,
Neil Fraser,
W. C. Frazier,
Phil Fritz,
W. Gaskin,
B. F. Gehr,
Ira Gentis,
J. A. Given,
J. Gratto,
C. F. Green,
F. M. Griffith,
Peter Giusto,
L. D. Hadwen,
G. E. Hanks,
W. C. Harman,
J. Henderson,
R. C. Henderson,
J. W. Holcomb,
W. T. Hopke,
J. Hunciker,
C. A. Jensen,
J. H. Johnston,
A. E. Kemp,
A. H. King,
H. H. Kinzie,
C. A. Lichty,
Harry Lodge,
G. Loughnane,
Wm. Mahan,
J. B. Malloy,
J. M. Mann,
G. A. Manthey,
A. S. Markley,
C. W. McCandless
W. H. McCoy,
D. McGee,
A. M. McLeod,
A. B. McVay,
E. C. Morrison,
C. T. Musgrave,
P. N. Nelson,
J. H. Nuelle,
J. F. Parker,
S. F. Patterson,
A. W. Pauba,
J. N. Penwell,
D. E. Plank,
Harry Pollard,
Homer Pollard,
G. W. Rear,
J. S. Replogle,
H. Rettinghouse,
C. W. Richey,
M. Riney,
J. S. Robinson,
G. A. Rodman,
Norman Rose,
G. T. Sampson,
F. E. Schall,
J. B. Sheldon,
D. A. Shope,
Wm. Spencer,
J. M. Staten,
E. G. Storck,
T. J. Stuart,
L. W. Swan,
Wm. Sweeney,
J. L. Talbott,
S. C. Tanner,
D. B. Taylor,
F. A. Taylor,
J. J. Taylor,
J. B. Teaford,
C. S. Thompson,
O. E. Ullery,
E. J. Vincent,
C. Warcup,
Chas. Wehlen,
F. E. Weise,
A. Weldon,
E. R. Wenner,
M. R. Williams,
M. M. Wilson,
A. A. Wolf,
J. P. Wood,
J. W. Wood,
D. C. Zook.

The following applicants for membership, subsequently elected, were also present:

H. L. Archbold,
W. W. Casey,
J. H. Clark,
Julius Froese,
J. H. Grover,
Robt. Hansen,
J. M. Hinchee,
E. T. Howson,
J. A. Hutchens,
A. T. Mercier,
L. T. Seeley,
Chas. Scott,
G. H. Stewart,
Thos. Tretheway.

Total number of members registered, 126.

Charter members present: A. S. Markley and G. E. Hanks.

Past presidents in attendance: A. S. Markley, C. A. Lichty, J. B. Sheldon, H. Rettinghouse and F. E. Schall.

The President:—Next in order is the reading of the minutes of the last meeting, but as they have been published and every member has had access to them it will be unnecessary to have them read at this time, unless someone has an objection or correction to offer. If there are no objections they will stand approved.

The next order of business is the admission of new members. We will now have the report of the membership committee.

REPORT OF COMMITTEE ON MEMBERSHIP.

You will note that the membership committee has been active during the past year from the list of new members presented herewith. Many of our old members have been on the lookout for new members in their vicinity. There are still many large systems of railroads which are not represented in our membership, and still others which have a very small representation. We should take steps to see that such roads are represented, if possible. This association stands for that which is best to assist the members of the bridge and building profession, and we should not only be represented by these roads, but we should receive experience from their members. It may be of more than passing interest to note that we have one application from Japan.

The following list of applicants is presented for your consideration, and their election to membership is recommended by the committee.

A. H. King, Chairman.

LIST OF APPLICANTS FOR MEMBERSHIP.

Archbold, H. L., Asst. Engr., Sou. Pac., Los Angeles, Cal.
Bach, C. F., For. B. & B., C. & N. W., Belle Plaine, Iowa.
Baluss, F. C., Engr., B. & B., D. M. & N., Duluth, Minn.
Bowman, R. M., Asst. Engr., L. E. & W., Indianapolis, Ind.
Buck, A. J., Chief Carpenter., C. M. & St. P., Tacoma, Wash.
Camp, W. M., Editor, Railway Review, Chicago, Ill.
Casey, W. W., For. B. & B., K. C. S., Texarkana, Texas.
Clark, J. H., Asst. Engr., Sou. Pac., Los Angeles, Cal.
Easton, G. A., Scale Insp., Sou. Pac., West Oakland, Cal.
Froese, Julius, Gen. For. B. & B., A. T. & S. F., LaJunta, Colo.
Graham, F. M., Asst. Engr., C. & N. W., Boone, Iowa.
Grover, J. H., Gen. For. W. S., A. T. & S. F., Needles, Cal.
Guire, W. A., For. B. & B., St. L. I. M. & S., Lake Providence, La.
Guppy, B. W., Engr. Structures, B. & M., Boston, Mass.
Hampton, H. A., Asst. Div. Engr., Sou. Pac., Portland, Oregon.
Hansen, Robt., Carp. For., Sou. Pac., West Oakland, Cal.
Hargrove, J. C., For. B. & B., St. L. I. M. & S., McGehee, Ark.
Hinchee, J. M., For. B. & B., Sou. Pac., Los Angeles, Cal.
Howson, E. T., Eng. Editor, Railway Age Gazette, Chicago, Ill.
Humbert, A. T., For. B. & B., B. & O., Pittsburgh, Pa.
Hutchens, J. A., Bridge Insp., Sou. Pac., Ogden, Utah.
Maruyama, Y., C. E., Sou. Manchuria Ry., Dairen, Japan.
May, A. D., Asst. Engr., Mo. Pac., Little Rock, Ark.
McFadden, T. E., Chief Carp., C. M. & St. P., Cedar Falls, Wash.
Mercier, A. T., Div. Engr., Sou. Pac., Los Angeles, Cal.
Meyer, H. W., Asst. Struct. Engr., G. T., Montreal, Que.
Murray, J. R., Supvr. B. & B., A. G. S., Tuscaloosa, Ala.
Pickering, F. M., Div. For. B. & B., B. & M., Salem, Mass.
Pinson, J. F., Asst. Engr. B. & B., C. M. & St. P., Seattle, Wash.
Rankin, W. F., Mast. Carp., Pa. Lines West, Cambridge, Ohio.

Rich, B. D., Painter For., Sou. Pac., Stockton, Cal.
Scott, Chas., Supvr. B. & B., B. R. & P., E. Salamanca, N. Y.
Sedmoradsky, C., Asst. For. B. & B., C. St. P. M. & O., Altoona, Wis.
Sedwell, G. W., Tunnel For., Sou. Pac., Bakersfield, Cal.
Seeley, L. T., For. B. & B., A. T. & S. F., Needles, Cal.
Shanklin, F. E., Gen. For., C. & N. W., Belle Plaine, Iowa.
Sisson, F. P., Asst. Engr., G. T., Detroit, Mich.
Spencer, Jos., For. B. & B., G. T., Stratford, Ont.
Stewart, G. H., Master Mason, B. R. & P., Salamanca, N. Y.
Thompson, E. E., Gen. For. B. & B., A. E., Phœnix, Ariz.
Thompson, J. L., Supvr. B. & B., D. & R. G., Salt Lake City, Utah.
Tratman, E. E. R., Editor, Eng. News, Monadnock Blk., Chicago, Ill.
Tretheway, Thos., For. B. & B., Sou. Pac., Stockton, Cal.
Urbutt, C. F., Asst. Engr., C. M. & St. P., Chicago, Ill.
Sydell, A. C., Chief Draftsman, C. B. & Q., Chicago, Ill.
Total number of new members, 45.

The secretary was authorized by a vote of the association to cast one ballot for the election of the applicants presented, whereupon they were declared members and entitled to all rights and privileges of the association.

REPORT OF THE EXECUTIVE COMMITTEE.

No meeting of the executive committee was called at the close of the convention at Montreal in 1913. A meeting was held at the Congress Hotel, Chicago, Wednesday evening, March 18, 1914. The members present were, J. N. Penwell, L. D. Hadwen, G. Aldrich, Lee Jutton, W. F. Strouse, C. R. Knowles, and C. A. Lichty. Other members of the association present were, A. S. Markley, R. C. Sattley, A. McNab, R. H. Reid, W. O. Eggleston, A. Montzheimer, C. F. Warcup, O. F. Dalstrom, W. S. McKeel, J. B. White, W. L. Ratliff, and F. E. Schall. Letters were read from G. W. Rear, chairman of the committee on arrangements, which gave the information that the committee was making suitable preparation for the next annual meeting. The committee recommended the Hotel Alexandria for convention headquarters, and this action was ratified. The secretary was authorized to have 500 copies of the Track Scale report printed and put on sale. The questions of holding future conventions in central territory, and changing the date were freely discussed, but no action was taken.

A meeting was held at the Hotel Alexandria on Monday evening, Oct. 19, 1914, at which the following members were present: President Penwell, G. W. Rear, G. Aldrich, L. D. Hadwen, S. F. Patterson, and C. A. Lichty. Other members present were, J. F. Parker, W. S. Corbin, F. E. Weise, D. A. Shope, M. Riney, J. B. Sheldon, A. S. Markley, J. S. Robinson, and J. Gratto. The secretary made a comprehensive statement in regard to the financial and other conditions of the association. The chairman of the committee on arrangements submitted a tentative outline of the features of entertainment as provided by the committee. The president appointed Mr. Rear and Mr. Plank to look after matters pertaining to transportation on local lines. Other matters pertaining to the welfare of the association were discussed, but no action taken.

C. A. Lichty, Secretary.

REPORT OF THE SECRETARY.

Chicago, Oct. 13, 1914.

Twelve hundred copies of the 1913 proceedings were issued, 800 with cloth covers and 400 with paper covers. Two numbers of the Bulletin were published during the fiscal year.

Number of members reported last year,	524	
New members, 1913,	55	579
Deceased,	2	
Resigned and dropped,	20	22
Total members, 1914,		557

FINANCIAL.

Receipts.

Badges,	$ 6.50	
Dues and fees,	1,056.00	
Advertising,	1,168.60	
Sale of books,	53.70	
From treasurer,	300.00	$2,584.80

Disbursements.

Stationery and office supplies,	5.23	
Postage,	112.89	
Printing and engraving,	1,299.82	
Drafting,	72.90	
Editing,	65.00	
Treasurer's bond,	7.50	
Stenographer,	119.50	
Expenses of various committees,	44.85	
Salaries and office rent,	800.00	
Expenses of annual meeting at Montreal,	66.05	
Telephone, express, and exchange,	12.40	
	$2,606.14	
Deficit from last year,	72.92	$2,679.06
Deficit, 1914,		$ 94.26

Balance due for advertising, $160.

C. A. Lichty, Secretary.

REPORT OF THE TREASURER.

Fitchburg, Mass., Oct. 2, 1914.

To the Members of the American Railway Bridge & Building Association:

The treasurer presents the following report for the year ending Oct. 20, 1914:

Receipts.

Balance on hand Oct. 21, 1913,	$1,412.42	
Interest,	57.00	$1,469.42

Disbursements.

Paid to the secretary, Oct. 2, 1914,		300.00
Balance on hand, Oct. 20, 1914,		$1,169.42

Respectfully submitted,

J. P. Canty, Treasurer.

The President:—I will appoint J. S. Robinson, L. D. Hadwen and S. F. Patterson, as a committee to audit the accounts of the secretary and the treasurer, and J. B. Shelden, J. H. Nuelle and Geo. Loughnane, as a committee on resolutions.

Mr. Fred E. Weise was appointed assistant secretary.

REPORT OF COMMITTEE ON RELIEF.

Joliet, Ill., Oct. 10, 1914.

To the Members of the Railway Bridge & Building Association:

The committee on relief has had no requests for relief during the past year. It seems remarkable that we have had no applications, considering the slack times, and indicates that our members are pleasantly situated.

Respectfully submitted,

A. Montzheimer, Committee.

The Secretary read communications from several of the past presidents.

The Secretary:—There are quite a few people on this side of the mountains who have never seen one of the most prominent characters in this association, and we want you to get acquainted with the man who is commonly known as "the deacon." Mr. Patterson was for 18 years secretary of this association, and to him belongs much of the credit for making this association what it is. I want you all to get acquainted with him. I want to say for Mr. Patterson that he has a wonderful record. This association is 24 years old, and Mr. Patterson has never missed an annual convention.

(Applause.)

Mr. Patterson:—Most of my brothers here know that I am not a speaker. I wish to say, however, that I am thankful for the opportunity of being here today, and to Mr. Lichty for his kind remarks.

The President:—We will take a recess of 10 minutes for the payment of dues.

Adjournment was then taken until 1:30 P. M.

AFTERNOON SESSION.

Tuesday, October 20, 1914.

The Secretary:—I wish to state that the American Railway Association has sent two members of its scale committee here to confer with us on the subject of track scales. These gentlemen,

Mr. Epright and Mr. Maxey, are in the hall at the present time, and I suggest that in the absence of the scale committee, our executive committtee discuss this matter with these gentlemen and come to some understanding with them regarding the course to be followed in the future with reference to the subject of track scales if it should again come before our association in the near future.

It was decided that an effort should be made to have the committees from the two associations meet at some time in the near future to consider some suggested changes in the report made by this association in the event that another edition be printed.

The President:—We will next take up the subjects for report and discussion. The assistant secretary will please read the paper on Subject No. 1,—Ice Houses. (See report and discussion which followed.)

Subject No. 2, Warnings for Overhead and Side Obstructions, was next read by the assistant secretary. (See report and discussion.) After considerable discussion it was decided that the subject should be continued next year, devoting particular attention to the question of side clearances.

There was no report presented on Subject No. 3, Railroad Crossing Gates, Towers, etc. It was decided to continue the subject for the next year.

Subject No. 4, Reinforced Concrete Bridge Work, was next read by the assistant secretary. In the absence of the chairman, Mr. Hadwen, a member of the committee, stated that the committee had much more valuable information coming in and suggested that it would be a good plan to continue the work of the present committee. It was so decided by a vote. (See report and discussion.)

The President:—We will next take up Subject No. 5, Station Buildings for Passenger Service.

The secretary announced that he had had considerable correspondence recently with Mr. Long, chairman of this committee, wherein he stated that the committee had sufficient data for a good report, but it was not yet in proper shape.

It was decided by a vote that the subject be carried over until next year.

EVENING SESSION.

Tuesday, Oct. 20, 1914.

The evening was given over to a banquet which was held in the Hotel Alexandria under the auspices of the Coast members.

Mr. Rear acted the part of toastmaster and besides short talks from a number of our members, an address was given by Mr. W. H. Whalen, division superintendent of the Southern Pacific, and an illustrated stereopticon lecture by Mr. Bayley, assistant engineer for the city of Los Angeles, on the recently constructed aqueduct which supplies the city with water.

MORNING SESSION.

Wednesday, Oct. 21, 1914.

The President:—In accordance with the constitution the report of the committee on nominations shall be read at the first session of the second day of our convention. The secretary will please read the report of the committee.

REPORT OF COMMITTEE ON NOMINATIONS.

Cleveland, Ohio, Oct. 7, 1914.

The committee on nominations submits the following report:

For President, L. D. Hadwen; First Vice-President, G. Aldrich; Second Vice-President, G. W. Rear; Third Vice-President, C. E. Smith; Fourth Vice-President, E. B. Ashby; Secretary, C. A. Lichty; Treasurer, J. P. Canty. For Executive Members, W. F. Steffens, S. C. Tanner, Lee Jutton, W. F. Strouse, C. R. Knowles, and F. E. Weise.

The President:—Gentlemen, it will be necessary for this report to lie over until tomorrow when the election will take place. However, the acceptance of this report does not bar anyone from making other nominations.

We will now proceed with Subject No. 6, Mechanical Coaling Stations, of which committee Mr. A. O. Cunningham is chairman.

The secretary announced that Mr. Cunningham gave out the information that a progress report was almost ready, and that the committee would try and get out the report in time to incorporate in this year's proceedings. (No discussion.)

The president announced that Subject No. 7, Elimination of Grade Crossings, would next be taken up; Mr. G. T. Sampson, chairman.

There was some discussion as to the proper title for this paper, but it was suggested by the committee that it be changed to read: Care of Traffic and Construction of Bridges to Eliminate Grade

Crossings. It was finally so decided. (See report and discussion following same.)

The President:—Subject No. 8, Water Supply, will be taken up.

Mr. Knowles, the chairman, being absent, extracts from the report were read by the assistant secretary.

The forenoon session was prolonged until 1:00 o'clock because of the trip to Redondo Beach and Venice, which had been arranged by the entertainment committee to start at 2:15.

Subject No. 9, Concrete Culvert Pipe and Concrete Piles was carried over until next year in order to add more information to the subject in the line of data pertaining to the cost and manufacture of the products.

No report was submitted for Subject No. 10, Heating, Lighting and Ventilating Round Houses and Shops.

Subject No. 11, Concrete Posts, Poles and Signs, was taken up, and in the absence of the chairman of the committee the report was read by the secretary. (See report and discussion.)

The discussion of this subject was not completed at the time of adjournment but was carried over until Thursday morning.

AFTERNOON SESSION.

Wednesday, Oct. 21, 1914.

The meeting adjourned at 1:00 o'clock, and at 2:15 the members of the association and their friends started for Redondo Beach and Venice, where the evening was spent at the shore.

MORNING SESSION.

Thursday, Oct. 22, 1914.

The discussion of Subject No. 11 was resumed and completed.

The report of the committee on auditing the accounts of the secretary and the treasurer was received as follows:

Los Angeles, Oct. 21, 1914.

To the Members of the American Railway Bridge and Building Association:

The committee on auditing the accounts of the secretary and the treasurer has carefully gone over and examined the accounts and books for the past year and finds the same to be correct as presented.

J. S. Robinson,
L. D. Hadwen,
S. F. Patterson,
Committee.

The report was accepted.

The President:—We will hear the report of the committee on subjects.

Mr. Weise:—Before making this report, I want to extend my thanks to the other members of the committee. It is the first committee I have been on in which the members have all taken active interest. Whenever I have written any one of them I have always received a prompt reply, and many good suggestions. While the work of this committee is not strenuous, yet it is not an easy task to select subjects that will bring out discussions, and subjects that committees can work on.

Of course, the selection of committees is not up to this committee; but the selection of committees has a good deal to do with the selection of subjects as one will not, of course, work on anything he is not interested in.

It has been stated here that committee work is probably the best work of the association; it brings out what is in the association and it is of benefit to the committees if they get together. The burden of the work naturally falls on the chairman. It is a task to get the work in shape, but the other members of the committee can be of great assistance.

In selecting the subjects for the coming year, we have tried to take things of interest. There are a number of subjects that might be selected. For instance, we are all interested in concrete, and we must have a subject on that. We must have something in connection with water supply, because there are so many members in that line of work, and while we may not all be interested in all of the subjects, we are all interested in general information, and when the committee on subjects gets to working they find they get more subjects than can be lined up in one season. We found it necessary to eliminate some of the new subjects first proposed because some were continued from the past year.

REPORT OF THE COMMITTEE ON SUBJECTS.

While the work of the committee on subjects is not as strenuous as that of some of the other committees, the matter must be given thoughtful consideration and a large amount of correspondence is involved. The subjects selected must be of interest and value to the members of the association. They must also lead to profitable discussions.

The value of the association to the members is represented by the committee reports, and as has been frequently stated, committee work is most profitable to the active members of the committee. While the chairman must take the initiative and assume a large share of the work,

it can be made much easier if he is able to secure the hearty and prompt coöperation of the committee members.

We take the liberty of making a suggestion, not only to members of committees, but to all members of the association. If you receive a request for information for a committee report, read it over carefully and make immediate reply, giving the best information at your command. If at this writing you cannot answer as fully as you would like, say that you will follow it up with more complete information, setting a definite time, say a week or a month later. A prompt response will show your interest, will be much appreciated by the committee, and will spur the members to take an added interest in this work. Do not put aside an inquiry to be answered at a more convenient time, because that time may never come. Your best thoughts come while you are busiest, because then your mind is most alert.

The subjects recommended for next year, accompanied by explanatory notes showing more definitely the field to be covered, are as follows:

1. Locomotive cranes as used in bridge and building work,—as used in construction work, handling material in supply yards, and other uses.

2. Conditions under which pile and timber trestle bridges should be repaired, reinforced, renewed, or replaced,—effects of soil, climate, and animal and vegetable life, the application of paints and preservatives, when and in what manner are repairs to be made, the reinforcing of bents and stringers, when and in what manner are extensive renewals to be made, under what conditions should one replace with a similar structure, under what conditions should one replace with permanent work?

3. Railway water tanks.—Types, wood, steel, concrete, sizes and styles for different locations, permanent and temporary water stations, materials used in construction of staves and hoops, precautions to prevent freezing, and care of tanks during freezing weather, frost proofing, foundations, towers or husk frames.

4. Coaling stations for the economical handling of coal at smaller stations using 25 to 50 tons per day.

5. Costs of structures.—Details to be kept in the time book, reports of material used, records to be kept in a division office, records to be kept in the general office, analysis of costs, the value and use of unit costs, gathering cost data for valuation purposes, blank forms.

6. Efficient methods of handling work and men.—A washout that was taken care of quickly because of some special appliance or organization; opening a bridge to allow dredge to pass through; unloading, storing, and shipping heavy material, such as bridge girders, turntables, etc.; elimination of water losses; other efficient methods, etc.

The following subjects are being continued:

7. Warnings for overhead and side obstructions.—Special consideration is to be given side clearance; tabulate the requirements of the various States.

8. Reinforced concrete bridge work.—To include the information that came to the committee too late to be included in this year's report, and also to include the work in the field.

9. Station buildings for passenger service only.

10. Concrete culvert pipe and concrete piles.

11. The protection of highway grade crossings with gates, towers, signals, flagmen, etc.

In conclusion we further recommend to the chairmen of the various committees:

Compile your reports and send them to the secretary, together with photographs and drawings for reproduction, not later than August 1. Ask him to send you a supply of advance copies, and upon their receipt, send them to such members of the association as have had experience in that particular line of work, asking them to prepare discussions, to be presented orally at the convention or sent in writing. Send the secretary

the names of those that have been invited to prepare discussions.

This method will bring about a more comprehensive discussion of the subject, will stir up greater interest in the meetings, and will result in the collection of very valuable information and opinions.

Respectfully submitted,

F. E. Weise, Chairman,
C. E. Smith,
M. Riney,
A. H. Beard,
Committee.

REPORT OF OBITUARY COMMITTEE.

McKee's Rocks, Pa., Oct. 12, 1914.

To the Officers and Members of the American Railway Bridge & Building Association:

WHEREAS, During the last year it has pleased Almighty God in His all-wise judgment to remove two of our respected members from this association by death. While, as loyal subjects of the heavenly kingdom, we cannot question the motives of the Divine Providence, we must bow to the will of our Father in all things that He decrees though we do not understand His purposes. Therefore be it

Resolved, that we deeply and sincerely mourn the loss of these members: W. E. Harwig and John Hubley, and that it be further

Resolved, that this association tenders its warmest sympathy and condolence to the widows and families of these deceased members in their bereavement, with the earnest prayer that they may be comforted by the God of all comfort,

And that it be further

Resolved, that these resolutions be entered in our proceedings and a copy thereof sent to each of the respective families.

D. L. McKee, Committee.

Mr. Rear:—The Southern Pacific has recently lost its third member of this association by death. I now refer to the late lamented John Hubley. Some of our members knew him personally and know what a hard fight he made for life. He died within sight of the bridge he was working on. Even when the doctor told him that there was little hope he decided to continue the battle, and remained at work until a few days before he died from tuberculosis. I think I voice the sentiment of every one of our Southern Pacific members when I say that when we lost Mr. Hubley we lost one of the bravest men who ever worked for a railroad.

The President:—Several of our members took it upon themselves to go over our Constitution and By-Laws very thoroughly, and they have some changes to suggest. I will call upon the secretary to present the matter to the association.

The Secretary:—A copy of the Bulletin was mailed to each member 60 days or more prior to the convention, which contained a copy of the old text and the proposed text of the constitution. Very few important changes have been proposed, but they were

more in the nature of a revision. One of the important items was the transfer of Article VII from the constitution to the By-Laws.

The changes were cited by the secretary, and after the reading and some discussion the proposed changes were adopted as a whole.

The publication committee had no report to offer. The secretary stated that the committee rendered excellent service when called upon.

The President:—We will now proceed to the election of officers for the ensuing year.

The secretary read the report of the nominating committee.

Some one suggested that it would be better to have the secretary and the treasurer located in the same place. Thereupon the name of F. E. Weise was suggested for treasurer and in his stead the name of Arthur Ridgway was placed on the list of proposed executive members.

The President:—We will first proceed to the election of a treasurer which will be by ballot. I will appoint J. S. Robinson, J. P. Wood and F. E. Schall to act as tellers. I wish to make an explanation. I do not want any member of this association to think that we are casting reflections on either nominee by having two nominations for the office of treasurer. The present treasurer lives in the far east and the secretary in Chicago. It was suggested to me as well as to the secretary and the executive committee that it would be more convenient for the treasurer to be located in the same city. That is without doubt what brought about the second nomination. I think that this word of explanation is due our members in order that they may understand the attitude of the executive committee and the members who proposed the change.

The vote resulted in the election of Mr. Weise. It was moved and seconded that the secretary emeritus cast one ballot electing the other officers. The vote was unanimous and the retiring president declared the officers elected for the ensuing year.

The President:—The time has arrived for installing the new president. I wish to say a few words now for after he takes the position he may not allow me to talk as much as I have been accustomed to. I want most heartily to thank you, gentlemen, for the most excellent order that has prevailed during every session. It was stated when the first session was called that we would call to order on time, and in every instance you were on time. These sessions have been better attended than those of any other meeting that I have attended, and the credit is due you for carrying out the

work promptly and on time. I do not wish the opportunity to pass without publicly thanking those who assisted me in my official position during the long siege of sickness which prevailed in my home. For months my wife, my wife's mother and my mother all lay sick. Through the kindness and loyalty of the secretary and other members who reside in Chicago the work was carried along in an efficient manner. I appreciate the assistance these gentlemen rendered, as well as that of every member of the association.

Mr. Hadwen, you have been elected to the highest position in the association. Do you accept the honor?

Mr. Hadwen:—I do.

Mr. Penwell:—In tendering you the gavel I do so with the very best wishes toward you as my successor. I know that you will have the confidence of every member, and knowing your executive ability and fine character I have every reason to believe that the association will grow and prosper.

You will find this association composed of good fellows. I bespeak for you success, and pledge you my assistance. I will be glad to help in any way I can. (Passing the gavel.) You are now duly installed as president of this association.

Mr. Hadwen:—Mr. Retiring President and fellow members: I am overwhelmed with the words with which our retiring president has seen fit to introduce me. The presidency of this association—an international association I might say, for we have many members across the border and in foreign lands—is an honor that will require every endeavor on my part to live up to. I can only assure you that my efforts to promote the interests of this association and to care for them, and to preserve the fine record it has, will be put forth to the utmost of my endeavor. I have in our retiring president such a splendid example of attention to duty under such circumstances and hard afflictions that I can only hope I may be given strength to bear myself in the noble manner that he has.

The time is getting short, and it has never been customary for the incoming president to make a speech, so I am not going to try to do so. The president has a year in which to collect his thoughts before he is expected to address you in any formal way, and I am very thankful for it.

Our retiring president is a little afraid he will not get a chance to talk as much as he wants to. I can assure him that we will be glad to hear from him, and all the other past presidents, at any time. They have demonstrated their value to the association in

a way that possibly no other members have had an opportunity to do, and they know the needs of the association better than anyone else. They should be in the foreground in all discussions.

The success of this association is largely dependent upon the committee reports we get out, and the value of the committee reports depends on the efforts of the individual members of the committees, and not on the chairman alone. I trust that on the committees appointed this year every member will feel that he has a duty to fulfill, and will give his chairman all the assistance he can, both in collecting information and in digesting it. There has been a criticism of some of our committee work, to the effect that there is not enough team work. Let each committee be a team. If you men were out for the football pennant you would work together. Let each committeeman think it is a football team and push the ball (its report) along.

Just one more word, that has been brought to my mind by a letter from Past President McGonagle. He hinted that each of us should strive to fit ourselves for the next position above. I know of no way in which we can demonstrate our value to our superior officers and make them anxious to see us promoted, than by the efforts we make in this association in furthering whatever particular work we are individually interested in on the committees.

Gentlemen, I don't want to take more time now, because we have some more business to transact before we adjourn to enjoy more of the hospitality of the Californians; but I do want to ask that you continue the splendid record that has been made in this convention for close attention to the work in hand, and remain until we complete our task, without anyone getting away just at the close. Stay until the business is finished, and we will get through quickly, as Mr. Penwell has so well put it. Gentlemen, I thank you.

Mr. J. P. Wood:—Mr. President; just a moment. In view of the fact that our retiring president has been laboring under trying circumstances during the past year, and considering the splendid record he has made during the year; and more particularly during this convention, which has been a record breaker for close attention, I would move that we give him a rising vote of thanks for his services.

The motion was carried unanimously with applause.

The President:—The first duties of my office are the installation of the new officers. I will proceed to install G. Aldrich first vice president; G. W. Rear, second vice president; C. A. Lichty,

secretary, and F. E. Weise, treasurer. The members of the executive committee, whose names were read to you a moment ago, are also duly installed.

The Secretary:—There is one other item of business to come up before we adjourn. I wish to place before the association the names of three members for life membership. I think all of you who know Mr. Killam will be glad to confer upon him the honor of life membership. Those of you who know him, know what his record has been; he has attended 16 conventions in succession. I think the honor is due him. Another is G. E. Hanks, a charter member, who is here. The third is Wm. Ross. All of these brothers have been retired from active railway service.

I would like to have you vote on these three names.

Mr. Sheldon:—I would move that all be elected.

The motion was duly seconded and carried.

Mr. Wolf:—John Foreman, Member No. 40, is an old member, now 92 years of age. I would suggest that a letter be written him by the secretary.

The President:—The secretary will arrange to write that letter.

The President:—The next in order of business is the determination of a meeting place for the 1915 convention.

Mr. J. P. Wood:—Mr. President, Ladies and Gentlemen of the association: In determining on a location for our next meeting place, I think it would be well to go back perhaps 5 years. You will remember, that in 1910, you met in the beautiful city of Denver. In 1911, you went farther east and met in St. Louis. In 1912 you met in Baltimore, down towards the sunny south. In 1913, you went to visit our Canadian brother in the extreme East, in the City of Montreal. The year 1914 assembles us here in the beautiful city of Los Angeles at the extreme west of the United States.

These meetings have been so distributed heretofore, in such beautiful places, that I believe each member who has attended them has seen something he had not seen before, and learned something new.

In determining on a meeting place for 1915, I wish to invite you to come to the middle west to a place that has not had a convention for many years; to a city which will rival the one in which we are meeting today.

While you people on the Pacific Coast feel proud of this city of yours, and of its wonderful progress, we believe we can show

you a city that will rival the beautiful city of Los Angeles. Perhaps we can not show you fruits and flowers in October, but we can show you a city noted for its streets and boulevards, its homes and industries; a city in which railroad men are vitally interested; the home of the American Car & Foundry Company. We can show you a city where they have a slogan, and one which I think the people go by: "A city worth living in." Those of you who know this place know that I am not stating anything but the facts. This is where we want you to come, that we may show you the beauties of a city of the United States whose reputation as a convention center is world wide. We can show you a city of half a million people; a city that is the center of the automobile industry of the world. More automobiles are manufactured there than in any other city, or, I might say, in any three cities, combined; we manufacture cars for the rich, and cars for the poor. It is a city of varied manufactures.

Gentlemen, I invite you to hold your convention next year in the city of the straits—the city on the St. Clair river—the beautiful city of Detroit.

(Applause.)

The motion was made by Mr. Rear, and duly seconded, that the nomination for next meeting place be closed.

The President:—You have heard the motion. It has been moved and seconded that Detroit be chosen as the city of our next convention.

Mr. Sheldon:—I move that the secretary emeritus be instructed to cast one ballot for the selection of Detroit.

The President:—The selection of Detroit as our next meeting place has been balloted on and determined.

Mr. Patterson:—I want to thank the association for the kindness and courtesy shown me all through this convention. Mr. McGonagle and others have mentioned my name very pleasantly, and I feel and appreciate it very much. I want to say that I recently made a little visit to our worthy past president, Mr. Travis. I had a very pleasant meeting with him, and spent ten days with him at his chicken ranch in the state of Washington.

The President:—We all, I am sure, feel that none of the meetings is complete without the "Deacon," and we hope and wish he will be able to attend a great many more meetings.

Mr. Corbin:—I am glad, in a way, that the convention selected Detroit as its next meeting place. I had the pleasure of attending

a convention in Detroit 15 years ago. I have attended a great many conventions, east, west, north and south, and I must say that Detroit gave us a hearty welcome, and we certainly enjoyed our stay in that city.

The President:—The next in the order of business is the presentation of the report on resolutions.

REPORT OF COMMITTEE ON RESOLUTIONS.

Los Angeles, Oct. 22, 1914.

Resolved, That the thanks of the association be extended to Mr. H. V. Platt, assistant general manager, and Mr. W. H. Whalen, superintendent of the Southern Pacific Co., for their addresses of welcome;

To the Pacific Coast members and their families for their untiring efforts to which the success of this meeting is largely due; also, for their many courtesies to the individual members and their friends;

To the Atchison, Topeka & Santa Fe and the Pacific Electric companies for their courtesies and hospitality;

To the Southern Pacific, Western Pacific, Denver & Rio Grande, Union Pacific, Chicago & Northwestern, and other railways, and to the Pullman Company for the courtesies extended to our members en route to and from the convention;

To the commercial club and citizens of San Bernardino for the entertainment of our members in that beautiful city;

To the management of the Hotel Alexandria for the use of the convention hall, and the courteous treatment extended to our members and families;

To the officers and committees who gave valuable time and assistance in promoting the general welfare of the association;

To Mr. E. A. Bayley, assistant engineer for the city of Los Angeles, for his interesting illustrated talk on the subject of the great Los Angeles aqueduct.

J. B. Sheldon,
J. H. Nuelle,
Geo. Loughnane,

Committee.

No further business appearing the twenty-fourth annual convention adjourned Thursday, Oct. 22, at 11:45 A. M., to convene at Detroit, Oct. 19, 1915.

In the afternoon, after adjournment, the members and their friends took a trip to Mt. Lowe, where an excellent supper was served at Alpine Inn, at an elevation of 5,000 ft. The descent was made in the night in order to get a view of the gorgeous display of city lights below, as the train wended its way down the side of the mountain.

Samuel Clarke,
Stenographer.

C. A. Lichty,
Secretary.

MEMOIRS.

C. C. MALLARD.

Charles Colcock Mallard was born in Walthourville, Ga., April 27, 1860. He was a son of Rev. R. Q. Mallard, a leading Presbyterian minister, and his mother was the daughter of a prominent Presbyterian clergyman. Mr. Mallard moved with his parents to New Orleans when he was seven years of age. Here he was reared and received his early education. He attended college at Clarksville, Tenn., although owing to adverse circumstances he did not graduate, but took up his burden as bread winner at an early age.

Mr. Mallard began his railroad career as a rodman, in Louisiana, under Julius Kruttschnitt, now chairman of the executive committee of the Southern Pacific, who advised the slip of a boy what to read and study, and helped and encouraged him in many ways. With the exception of two years spent on railroad construction work in Texas, Mr. Mallard was with the Southern Pacific in Louisiana as roadmaster, superintendent of bridges and buildings, division engineer and assistant division superintendent until about seven years ago when he became su-

perintendent of the Arizona Eastern (of the Southern Pacific system) at Globe, Ariz., which position he held at the time of his death.

Mr. Mallard was strong in body and on this account was easily deceived as to the serious character of the ailment from which he had been suffering for many months prior to his demise. Just before his death he had been sent to his old field in Louisiana on a business trip. Upon the completion of his duties he went to the home of his sister, Mrs. W. K. Seago, in New Orleans, apparently in good health. Within 24 hours he was feeling so badly that medical aid was summoned. He was hurried to Touro Infirmary where it was found that the appendix and gall bladder were involved. He underwent an operation from which he did not recover.

The funeral was held from the residence of his sister, Mrs. Seago, 1917 Berlin St., New Orleans, Nov. 25, 1914, and was attended by many prominent railroad men.

Mr. Mallard was president of the board of trustees of the Presbyterian church of Globe, Ariz., and was a member of the American Railway Engineering Association, and of the American Railway Bridge and Building Association. He joined the latter association at Cincinnati in 1892.

JOHN HUBLEY.

John Hubley was born in Pittsburgh, Pa., May 15, 1870, and died at San Luis Obispo, Cal., April 19, 1914, after an illness of several months. He began railroad service with the Southern Pacific Company in 1892, and for the past ten years was in charge of steel bridge erection. He is survived by his wife and two children.

John Hubley.

Funeral services were held in Berkeley, Cal., with interment in Mountain View cemetery. These services were attended by a large number of the members of the association.

Mr. Hubley joined the association in 1911.

W. E. HARWIG.

William E. Harwig was born in New York City in October, 1850. At the age of 17 years he started work as an apprentice with a house carpenter, and at the age of 20 became a journeyman carpenter for about a year. From 1870 to 1871 he was engaged as a rodman with a U. S. survey party in Southwest Kansas.

From 1871 to 1879 he worked as a bridge and house builder and from 1879 to 1890 he was employed as a switchman, car inspector and yard master. From 1890 to 1896 he again followed carpenter work. In 1892 he was appointed foreman carpenter on the Lehigh Valley on its extensive terminals at Jersey City, N. J., in which capacity he remained until 1896, when he was appointed master carpenter. In 1900 he was promoted to supervisor of bridges and buildings of the New Jersey & Lehigh division of the Lehigh Valley, which position he filled successfully

William E. Harwig.

until 1909. From that date until 1911 Mr. Harwig acted as inspector on construction work on the Lehigh Valley, and from 1911 to 1913 he was employed as supervisor of bridges and buildings on the Lehigh & New England, from which position he retired to a well-deserved rest.

Mr. Harwig was unassuming and kind-hearted and a man of the true type; he was highly esteemed by his townsmen of Phillipsburg, N. J., was for 23 years honored as a member of the board of education and did much in the upbuilding of the school system of that city, being president of the board for nearly a decade. As a mark of respect and esteem for his services one of the school buildings bears his name. Mr. Harwig was an active church worker and an honored member of the masonic fraternity and of a number of other organizations. He joined the American Railway Bridge and Building Association in 1896 and has always exhibited a lively interest in it.

W. S. SCHENCK.

Winfield Scott Schenck was born in the Shenandoah Valley of Virginia at Bartonsville, May 8, 1849, a son of Henry Franklin and Mary Schenck, and died at his home in Connellsville, Pa., Dec. 3, 1914. Heart trouble contributary to pneumonia was the cause of his death.

Mr. Schenck was educated in the private schools at Stephen City, Va., and learned the carpenter trade, serving as an apprentice under George Lambden from 1867 to 1870 at Winchester, Va., where he worked as a journeyman until 1872. He then left Virginia and after six months spent in Cumberland, Md., located in Somerset, Pa., where he remained until the winter of 1873, going thence to Frostburg, Md., for a few months, after which he went to Braddock, where he remained until April, 1875, when he located in Connellsville, entering the employ of the Baltimore & Ohio April 9, 1875, as a day carpenter. He served in that capacity until 1881, when he was promoted to the foremanship of a floating gang; later he was promoted to be foreman of the road department shops at Connellsville, continuing until 1885, when he was advanced to the position of master carpenter of the Pittsburgh and Connellsville division, which position he held until his death.

W. S. Schenck.

Mr. Schenck had an enviable record as a bridge man and at one time made the record of removing an old bridge from its location and replacing it with a new structure, ready for traffic in 23 minutes, the two combined bridges weighing over 40 tons.

On Dec. 16, 1879, Mr. Schenck married Sarah Jane Shaffer, who survives him with two sons and a daughter. Besides being a member of the American Railway Bridge and Building Association he belonged to the Royal Arcanum and was an elder in the Christian church at the time of his death.

H. E. HOLMES.

H. E. Holmes was born in Salem, Conn., February 8, 1860. He began his services with the New London Northern R. R., now Central Vermont Ry., in 1881, as a painter in the bridge and building department. He served in that capacity during the summer months and was transferred to the bridge construction gang in the winter months, where his services were so satisfactory that he was in 1892 promoted to the position of foreman in charge of bridges and buildings between Brattleboro, Vt., and New London, Conn. A few years later his jurisdiction was extended to cover the territory including South Londonderry, Vt.

H. E. Holmes.

Mr. Holmes was passing through the railroad yard at his division headquarters, New London, Conn., about 5 o'clock on the afternoon of November 12, 1913, while on his way to the work cars to leave instructions for the following day when, evidently misjudging his distance from the track of the main line, he was struck by a passing train, being thrown a considerable distance. He sustained such severe injuries that he died a few hours later at the general hospital.

Besides his widow, Mrs. Emma R. Holmes of 432 Williams St., New London, Conn., he is survived by one son, Harry, six years of age, and a brother, F. H. Holmes who resides in the same city.

Mr. Holmes joined the American Railway Bridge and Building Association at the Detroit convention in 1899.

JAMES McINTYRE.

James McIntyre was born near Ekfrid, Middlesex County, Ontario, in 1840. He was the third of twelve children, and grew up on a farm with his father and mother who had emigrated from Argyllshire, Scotland, in 1820. Many of his pronounced characteristics were the direct result of his Scotch training. His early education was that of the country schools, but his father, a University man, was able to teach him the value of English literature and of history, which he enjoyed up to his death.

At eighteen years of age James McIntyre joined his brother in contracting work in northern Minnesota and from that training in bridge building he became one of that army of railroad pioneers which built the Central Pacific Railroad over the western plains. It was an interesting time in railroad history. For months, Indians harassed the men so that

James McIntyre.

United States troops had to protect the bridge builders. When Mr. McIntyre could be induced to relate his experiences of western raliroading, he would tell many thrilling stories of pioneer life in a railroad camp.

Two years of the Civil War were spent in army contract work in rebuilding the bridges burned by the Confederate army throughout Tennessee, Georgia and Alabama. Often the timbers would be smoking from the fires of the Southerners, as the bridge men set to work. After a few years in railroad bridge building in St. Joseph, Mo., Mr. McIntyre settled in Cleveland, Ohio, working in the capacity of superintendent of

bridges and buildings for the Atlantic & Great Northern Railroad, afterwards the N. Y. P. & O., and now a part of the Erie system.

For thirty-three years Mr. McIntyre lived in Cleveland. Nine years ago he moved with his family to Miami, Fla. With the same energy that he formerly had devoted to railroad work, he now turned to planting an orange grove. Life was as interesting to him under new conditions, as it had been under the old. He quickly identified himself with the interests of Miami, eager for all the industrial improvements of that part of the south. His health which had always been good suddenly began to fail in June, 1914, and he was ill from that time until his death, which occurred January 4, 1915. His illness was long and painful, but his zest for life remained until the end. Life was always full of interest to him. He enjoyed the letters of his friends in the north, and the ties of friendship were very strong.

James McIntyre was a Christian. He lived a life eager for good, always unostentatious, but his actions were governed by a firm belief in God. When he died he was an active elder in the First Presbyterian Church of Miami, and had been active in Sunday-school work, both in Cleveland and Miami for many years.

He leaves a widow, Mary Clover McIntyre; one daughter, Anna C. McIntyre, of Cleveland, Ohio, and two sons, Milton D. McIntyre, of Cleveland, and Angus C. McIntyre, of Miami, Fla.

Mr. McIntyre was one of the early members of the Association, having joined at Chicago in 1896.

JOHN FOREMAN.

John Foreman, the oldest member of this Association, was born in Maxatawny township, Berks county, Pa., on July 25, 1823, and died at Pottstown, Pa., Jan. 7, 1915. In January, 1845, he left Berks county and went to Pottstown, Montgomery county, and in October of the same year was married to Catherine Leader.

Mr. Foreman was one of the grand old men of the Philadelphia & Reading system, with which he saw active service for 57 years. He died at the residence of his son-in-law and daughter, Mr. and Mrs. G. W. Corbett, 631 High St., Pottstown, Pa., in his 92nd year, after an illness of a short duration.

Mr. Foreman was an ardent supporter of the Association. He attended conventions as often as he could up to a few years ago. When he could not be present he would write a letter stating the reason as well as wishing the meetings success. His last letter to the association was written in Oct., 1914, after he was past 91 years of age.

He joined the Association at Kansas City in 1894, and was elected to life membership in 1902.

OWEN J. TRAVIS.

Owen J. Travis, the first president of our Association, was born in New York City, March 31, 1848 and died at Pinehurst, Wash., on Nov. 8, 1914. He attended common schools until 13 years old, then emigrated to Illinois and became a farmer boy until 1864 when he enlisted in the 133rd Ill. volunteer infantry. After being mustered out he returned to the farm where he remained until 1868, when he entered the service of the Keystone Bridge Co., at Kansas City, where a bridge was being erected over the Missouri river. He remained with that company in various capacities until 1872, having been engaged in the construction of some of the most important bridges of those days over the Mississippi, Missouri and Ohio rivers; those of particular note being two over the

Missouri river at Kansas City and St. Charles, Mo., two over the Ohio river, at Bellaire, and at Cincinnati,—and the Eads bridge over the Mississippi at St. Louis. Upon the completion of the latter he entered the service of the St. Louis Bridge Co., as collector, and later became superintendent of traffic.

In 1882 he moved to Salt Lake City and engaged in a commercial line which did not prove entirely successful. In 1882 he began work with the St. Louis, Kansas City & Northern (the western division of the Wabash), as general foreman of bridges and buildings. In June of the same year he was appointed superintendent of bridges and buildings of the middle division at Springfield, Ill. In 1884 he went with the St. Louis Southwestern for a short period, after which he returned to the Wabash as general foreman of bridges and buildings of the line from Chicago to St. Louis. He left the Wabash in 1888 to go with the Iowa Central at Marshalltown, Ia., as superintendent of bridges and build-

Taken at the Second Annual Convention.

As He Appeared in Recent Years.

OWEN J. TRAVIS.

ings, where he was employed until 1892, when he resigned to accept service with the Elgin, Joliet & Eastern, at Joliet, Ill., as superintendent of bridges, buildings and interlocking and later was made superintendent of maintenance, which position he held for five years.

In 1897 he was appointed superintendent of bridges for the Illinois Central, and the Yazoo & Mississippi Valley. In 1901 he became superintendent of bridges and buildings of the Colorado & Southern Ry. at Denver, and in less than a year his territory was extended to cover the Ft. Worth and Denver City.

In 1906 he retired to private life, settling on a ranch at Bow, Washington, in which place he spent a quiet life until his health began to fail in 1910. He then moved to California where he made his home until he was much improved in health when he removed to Everett, Wash. The last four years of his life were spent on a small ranch at Pinehurst, Wash., where he had a comfortable home. He leaves a widow, one son and a daughter. The son, Mr. J. E. Travis, is a member of the Association.

Mr. Travis was the moving spirit and was instrumental in getting together at St. Louis in 1891, a representative body of men who organized the Association of Railway Superintendents of Bridges and Buildings, and he was its first president. This was during the time that he was connected with the bridge and building department of the

Iowa Central (now Minneapolis & St. Louis) at Marshalltown, Iowa. The title of the Association met with a few slight changes in its early days when in October, 1908, it was changed to its present name, the American Railway Bridge and Building Association. Mr. Travis was elected to life membership at Milwaukee, in 1907. Although poor in health and living in the extreme western part of the United States, during the latter years of his life, his interest in the Association did not wane as was evidenced in the long trip which he and his wife made from Pinehurst, Wash., to Montreal, in 1913, to be present at the annual convention,—and by the very interesting letter which he forwarded to the Los Angeles convention less than a month before his death. In the last letter he mentioned how much pleased he was to entertain in his home for several weeks during the summer Mr. S. F. Patterson who served the Association for 18 years as its secretary.

Subject No. 1.

RAILROAD ICE STORAGE HOUSES.

REPORT OF COMMITTEE.

Railroad ice houses are for the purpose of storing supplies of ice at convenient points. The conditions governing the supply and demand are probably different than those surrounding any other material used in railroad operation. During a very considerable portion of the year the demand is largely in excess of the average, while during the remaining months the demand is always less than the average, usually very slight, and sometimes there is no demand at all. Considerable supplies are needed during the hot months at points far removed from points of supply and it is of greatest advantage in such cases to transport the ice during the winter months in order that the loss during transmission may be minimized and the ice houses filled at a time when they have been cooled by the low temperature of the air.

In the case of natural ice, advantage must be taken of the seasons, and a supply obtained when available during the winter, being distributed at that time to fill the ice houses at the various points where a demand will arise during the following months. In the case of artificial ice only small houses at outlying points must be supplied by ice hauled over a considerable distance as points where a large amount of ice is used can be supplied by the installation of an ice plant.

The points of supply of natural ice are controlled by nature and in the use of natural ice all other things must be made subordinate to its availability. The supply of artificial ice, however, can be controlled by artificial means, both as to amount and location. To keep the ice machinery going with reasonable uniformity the surplus supply in the winter months is usually stored and is available during the hot weather.

The demand is controlled entirely by the use that is made of the ice. At points where ice is used only for supplying local needs, the demand is fairly uniform through the months of any season, but less, of course, in the winter season than in the summer; this, however, makes the smallest demand, as the greatest demand is created by the handling of perishable freight, such as fruit, meats, etc. For the latter purpose supplies of ice must be furnished at points controlled by the location, traffic and operating conditions existing on each railroad. In some cases, as in the handling of meat, the number of refrigerator cars that must be iced continues fairly uniform throughout the year, the amount of ice required, of course, being greater in summer than in winter, while in other cases, as in the handling of fruit, there is practically no demand through many months of the year and there is a great demand during a short period. These features must be studied in order that the house may be designed to meet the conditions to which it will be subjected.

The type of construction that can be followed is merely a question of expense, one large item of expense being the cost of construction, maintenance and operation of the house and the other large item of expense the loss suffered through shrinkage of the ice. The problem is somewhat different from that encountered by cold storage companies that make a specialty of storing perishable goods of considerable value. In the latter case the most modern methods of construction and means of refrigeration must be employed in order to absolutely guard against a failure of the plant that would cause a tremendous loss through the decay of the perishable materials. In the case of railroad ice houses,

however, the only thing that is stored is the ice and defects in construction, failure in the plant, etc., will merely result in the loss of ice, which, while not so serious as the loss of perishable goods of greater value, is still so important as to necessitate the most careful construction at reasonable expense.

The percentage of shrinkage in stored ice is dependent on the efficiency of the insulation of the ice house and can be reduced, but not entirely eliminated, by proper insulation. Where only natural ice is stored, and where artificial ice is stored at points removed from the refrigerating plant it is necessary that all reasonable precautions be taken to keep the shrinkage at a minimum.

At points where refrigerating plants are operated it is possible to employ the additional precaution of keeping the temperature of the house below freezing by equipping each room within the ice house with cooling pipes that will keep the temperature so low as to entirely prevent the melting of the stored ice. The amount of power that must be applied to prevent the melting of the stored ice will be controlled largely by the type and efficiency of the insulation of the house. In any event, of course, it is important to so construct ice houses that the passage of heat from the outside to the inside of the house will be reduced to a minimum.

Many types of construction have been followed and great loss has been suffered on account of improper understanding of the conditions to be met. In some cases it has been considered sufficient to store ice directly on the ground and build four walls and a roof over it, decreasing the shrinkage by covering the ice with hay, sawdust or other similar materials. The extent to which such practice can be followed and the amount of shrinkage that may be suffered depends entirely on the cost and the supply of ice and the condition of its use. The cheapest type of construction will probably suffice at northern points immediately adjoining large lakes that freeze over every winter, where the cost of ice is very small; while in hot southern countries, where natural ice must be hauled in during the winter, or artificial ice manufactured at all times, very expensive types of construction are justified.

It is not generally understood that wood is a better insulator than brick or concrete and the problem of insulation cannot be solved by merely changing from a wood frame to brick or concrete construction without employing other means of insulation. Brick or concrete walls will prevent the circulation of air to a greater extent than some types of frame construction, but it is entirely possible to build wood frame ice houses so that the walls will resist the circulation of air through them just as well as brick or concrete walls. In either case, insulation must be provided, regardless of the type of construction, and when it is considered that brick and concrete houses cost from $4 to $6 per ton of ice storage capacity as compared with well constructed and insulated wooden houses costing $2 to $3 per ton, it is questionable, if, under all conditions, the more expensive type of construction is justified.

When brick or concrete houses are constructed the walls are of ordinary construction, but, in addition, their interior surfaces must be thoroughly insulated to provide against the passage of heat from the warm exterior into the storage rooms and this insulation can usually be provided in a wood frame house at no greater cost than in a brick or concrete house. At the present time the wood frame ice house is universally used, there being only a very few exceptions in the way of brick and concrete houses.

It is most important to absolutely prevent the circulation of air within the house, for if any circulation of air occurs the warm air will continually come in contact with the ice and cause its rapid shrinkage. while if the air is kept still, either by confining it to small spaces or holding it in porous materials it is the best insulation that can be found.

A feature that has been given but slight consideration is the insulation of the floor. A great majority of the designers have thought that

it would be sufficient to level off the ground and place the ice directly upon it, sometimes covering the surface with cinders, boards or concrete, but it has not been uniformly recognized that the floor must be thoroughly insulated. Heavy losses due to shrinkage at the floor line in a number of houses indicate that the stored ice will not overcome the ground heat which continually rises to the surface and melts the ice. In more recent houses the shrinkage from this cause has been largely reduced by providing air spaces between the ice and the ground, usually by placing joists and covering them with a slat floor for the support of the ice. Air spaces are from 6 inches to 12 inches between the bottom of the ice and the surface of the ground. With other construction so handled as to keep this air stationary this forms a good bottom insulation.

The foundations for the walls can follow the usual types of construction with proper regard to insulation. Foundations of concrete, brick, wood blocking, posts, pile stubs and other designs are much used. Especially where masonry foundations are used care must be taken to secure proper insulation. A concrete foundation wall projecting two or three feet above the ground line without inside insulation has been known to be the cause of heavy losses by the transmission of heat from the ground and outer air through the walls to the air near the floor, which rises and comes in contact with the ice resulting in great losses.

In porous soils the water from the melted ice is permitted to go directly into the ground but at other points drains must be installed. These are no different from other drains but special precautions must be taken to trap them so securely that no air currents can find their way into the houses through them. The amount of air entering a room containing 1,000 tons of ice through a 4-inch pipe can easily melt all the ice in a single season.

The information received from many sources indicated that ice storage rooms vary from 50 to 1,500 tons, the average being about 1,000 tons and the usual dimensions being 30 ft. wide, 40 ft. deep and 30 ft. high, although many other proportions are used as shown in the accompanying illustrations.

While many different arrangements, thicknesses and designs of wall construction are used they all follow the same general trend, that is, vertical studs 6 in. to 12 in. wide, covered on both sides with wood sheeting, building paper, etc. The best construction requires double sheeting inside and out, with waterproof building paper between the layers, the spaces between the sheeting from stud to stud being filled with insulating material.

It was formerly thought that air spaces afforded excellent insulation but the manufacturers of insulating materials have done their best to explode that theory. It is claimed that air in a space 8 in. or 10 in. wide, for example (although theoretically thinner spaces can have the same result), will be set in circulation by the air against the outer wall becoming warm and rising while that near the inner wall is cooler and falls. The difference in temperature of the air at the two sides of the space can certainly be great as air is a poor conductor of heat and it is evident that the circulation which rapidly transfers the heat that gets through the outer sheeting to the inner sheeting must be prevented. This can be done by cutting such spaces into smaller spaces by proper framing or by filling them with suitable porous insulating materials, which will fill the spaces but yet leave the greater part of the space, consisting of pores in the insulating materials composed of entrapped air, so separated as to permit no circulation.

In the past it was the universal custom to fill these spaces with sawdust or ground cork but on account of the continual dampness the sawdust decayed rapidly and brought about the decay of the timber enclosing it, which was also true of crushed cork. At the present time various materials are used which are specially treated and manufactured for this purpose, principally from flax, cork and limestone.

Flax is made up into blankets enclosed by sheets of waterproof paper. Cork is made up into cakes pressed and cemented together with asphaltum or other waterproof cement. Limestone is heated to 3500 deg. and when liquefied is blown into shreds so as to make a sort of rock wool enclosing a very large percentage of air bubbles forming excellent insulation. The latter material forms an excellent filling for ice house walls. The illustrations accompanying the report show a large number of types of construction of these walls.

The treatment of partitions is somewhat similar but as the difference in temperature between the two sides of the partitions is not so great as between the interior of the house and the exterior, the same care and insulation is not justified.

The two principal objections that can be raised to wood frame ice houses are the danger of fire and the decay of the timber. As timber lends itself so well to ice house construction, safety against fire can be obtained by covering the exterior walls with stucco and expanded metal and covering the roof with a fireproof material. Any openings into which birds might otherwise enter and build their nests should be covered by a galvanized iron mesh. Decay can be postponed for many years by treating the timber and there seems no good reason why treated timber should not be used in ice house construction.

Several of the large meat packers are still building ice houses of frame construction with excellent results as indicated by the following typical letter from The Cudahy Company:

"Attached hereto you will find copy of blue print showing side wall and roof construction of our Seymour Lake, So. Omaha, Neb., ice house, which we have reason to believe is the best storage house for ice in the country, the percentage of shrinkage being so low as to justify us in making this assertion. I understand that we have gone through two or three seasons with a shrinkage of only about 4 per cent in this house."

In brick and concrete houses walls must be insulated fully as effectively as for wooden houses. In some cases timber frames have been built inside the brick and concrete houses and filled with rock wool or other material similar to the method used in the wooden houses, but in by far the great majority of cases the inside surfaces of the walls are completely covered by slabs made up of waterproof materials such as cork, lithboard, etc., plastered to the walls and in some cases plastered on the interior.

There is very little difference in the type of roof used for the various kinds of houses. Steel trusses are seldom or never used on account of the rapid corrosion that would result from the dampness, wood trusses being sufficient. These trusses are usually so built that the roof covering can be applied to the top chord while the ceiling for the ice chambers can be applied to the bottom chord. This affords an air space between the roof and the ceiling of the ice house through which air can circulate and a good insulating air cushion results. The ceiling of the ice house must be insulated just as effectively as the walls and practically the same type of construction is made use of for that purpose.

The greatest care must be taken with the connections of the walls to the foundations and also with the connections of the ceiling to the walls and partitions in order that there may be no opening, however small, through which air can enter directly into the ice chambers.

The height of the attic space is usually not less than 3 ft. and varies in height to 8 ft. or 10 ft. as in some cases extensive machinery is located in this space. The space between the ceiling and the roof affords a good air insulator and the roof prevents the direct rays and heat of the sun from playing on the ceiling. The walls around this space should be built up tight enough to prevent birds from entering and building their nests. while there must be sufficient openings in the form of louvres to permit the free circulation of air. These louvres and any other openings should be covered with galvanized wire screening to keep out birds' nests and rubbish that would otherwise create a fire hazard.

The doors are usually of ordinary refrigerator construction with several sections separated by air spaces which air spaces are now sometimes filled with insulating material. The greatest care must be taken in the connections of the doors to the houses that no air can circulate between the door and the frame. In some houses doors are separated and in others they extend vertically from the top to the bottom of the house in each chamber. In the first the openings can be so controlled as to admit of the entrance of very little warm air to the chambers, while when the doors extend the full height of the house there is more likelihood of the entrance of warm air, and greater difficulty in keeping the joints between the doors tight.

Cakes of ice are stored in all sizes and on edge as much as on flat. In many cases the cakes are placed as close together and as close to the walls and partitions as possible, while in others spaces several inches wide are left between the cakes of ice and between the ice and the walls. It is difficult to understand the reason for leaving these spaces as they give the best possible freedom to the circulation of the air, resulting in increased melting of the ice which could be avoided by filling up the entire space between the walls with ice laid in contact, which, however, need not be of such forcible contact as would result in the cakes freezing together. This also applies to the individual rooms which should be filled up as close to the ceiling as possible.

In the past it was the quite universal practice to cover ice with sawdust and to fill all crevices between the cakes and against the walls with that material in addition to covering the ice over with several feet of it. That practice has practically ceased as it was found that the cleaning of the ice resulted in a very great loss due to the ice melting rapidly under the water used in washing it and sawdust and cork are not now extensively used for that purpose. The circulation of air among the cakes of ice is also decreased somewhat by placing alternate layers on edge and flat when the size of cakes is sufficiently uniform to permit.

However, it is necessary to use some means to keep the ice apart in order that the cakes will not melt together if shrinkage be rather rapid. In many cases strips of board have been placed between the layers of ice but that does not appear to have been very effective as the strips usually melt into the ice and permit the cakes to come together. More recent experiments have been tried in the use of waterproof paper to separate the layers of ice, which paper, of course, will effectually prevent the cakes from freezing together and will, in any case, prevent the circulation of air from layer to layer. In rooms holding ice that must be stored for many months for rapid use when demand arises it is well to cover the ice with a thick layer of some insulating material, such as hay or straw which will prevent the circulation of air. The use of materials that necessitate washing of the ice, however, should be avoided.

The length and width of the platform for handling ice between the cars and ice house depend upon the requirements and are set forth in more detail in the information received from the various roads. As a rule when conveyors are not used and ice is handled in buggies, a platform 16 ft. wide will be found to be very convenient, although narrower platforms have been successfully operated. Where a comparatively small number of cars are iced short platforms are sometimes built in front of the house of sufficient length to accommodate five to ten cars, a switch engine being required to handle the cars when there are more than can be placed at one time. Where there are many trains to be iced it is of considerable advantage to have an icing platform the full length of a train so that it can be iced at one spotting, especially at engine terminals where such trains do not need to be broken up.

The method used for distributing the ice along the platform also depends upon the amount of icing to be done. Where many trains are to be iced and platforms are long it is of advantage to use continuous platform

conveyors to carry the ice from in front of the ice house to the points where it is put in the cars.

In some cases, as in the case of a New York Central ice house described later in this report, adjustable platforms are built adjoining the house and continuous conveyors carry the ice to and from the house by adjustable inclines. Many houses, however, are built with no mechanical means for handling ice and temporary hoists operated by horse power or by temporary hoisting engine are used. Such means, however, are entirely inadequate at large houses. In the great majority of such cases vertical elevators or skips are used. The skips handle from 600 to 2,000 lbs. of ice each trip and some make as many as three trips a minute, the floor and wiring of the skip being so adjusted that the skip stops and the ice automatically slides off when the proper level is reached. Such elevators will handle from 500 to 1,000 tons per day in or out of the house.

In some cases ice is gotten out along the platform in advance of the arrival of trains and cars are iced with very little delay, while at other points, particularly where cars must wait for some time in any event, ice is gotten out while the cars are standing. The best method, of course, is to have the ice on the platform immediately in advance of the arrival of the train, where it can be covered and protected from the direct rays of the sun on hot days but, of course, if allowed to remain there for any great length of time the shrinkage is very large.

The information also indicated that wherever at all convenient and practicable the railroads rely on commercial ice companies for ice. This is especially true in the East where the greater density of population necessitates the manufacture of great quantities of ice, and the manufacturers can supply the additional amount required by the railroads at much less cost than the roads can furnish it themselves.

Especially in the West, however, it is necessary for the railroads to take care of themselves and it was decided to request from all the large systems a brief statement of their practice.

Before proceeding with the collection of information from the various roads, the chairman prepared the following circular letter and sent it to the other members of the committee for their approval and criticism:—

Dear Sir:—

The committee on ice houses of the American Railway Bridge & Building Association requests that you kindly send to the chairman, such information, blue prints, descriptive and statistical data as to costs, losses due to shrinkage, rules or instructions as to filling, emptying or other handling of ice, methods of packing, handling in and out, etc., as you may have readily available on this subject.

The fullest possible information is desired and it is hoped that you will co-operate with the committee in presenting a good report. The information on this subject is now scattered and it is thought much good can be accomplished by compiling and collating the best information.

The committee will be glad to give you a copy of its report on this subject when completed.

The following outline is suggested as a tentative guide in giving information relative to the various items:

1. Sizes and capacity of rooms.
2. Foundations under walls.
3. Foundations under floors.
4. Foundations under partitions.
5. Preparation and insulation of floors.
6. Types and insulation of wall and partition construction for frame house.
7. Ditto for brick house.
8. Ditto for concrete house.
9. Type and insulation of ceiling.

10. Type and insulation of roof.
11. Height and insulation of attic space.
12. Details of doors.
13. Details of platforms.
14. Details of platform conveyors.
15. Details of elevators, skids or other means of filling.
16. Rapidity and capacity of elevators or conveyors.
17. Methods of storage of artificial and natural ice.
18. Sizes of cakes.
19. Storage on edge or flat.
20. Spaces between cakes.
21. Cavities between ice and wall.
22. Space between ice and ceiling.
23. Insulation of ice.
24. Strip of wood between layers.
25. Paper between layers.
26. Sawdust between layers.
27. Cork between layers.
28. Covering of ice, if any.
29. Best method of handling when ice is all withdrawn from house during a short, busy period.
30. Best method of handling ice when withdrawn uniformly throughout a long season.
31. Method of drainage.
32. Types and capacity of trusses.
33. Percentage of shrinkage under various conditions.
34. Is ice distributed along platforms ahead of train or gotten out while trains wait?
35. Cost of any actual houses and cost of house per ton.
36. General information with reference to refrigeration, sizes, number, capacity of pipes, capacity of refrigerating plant, etc.

Yours very truly,

(Signed) C. E. Smith, Chairman,
Committee on Ice Houses.

The letter received the approval of all the committee members and was then sent to all the largest railroads. The replies indicated great interest in the subject, as practically all roads that have ice houses went into great detail in their replies and furnished full information and prints. About one-third of the roads reported no ice houses, relying entirely upon commercial plants along the line, while the remaining two-thirds comprising practically all the large systems, gave detailed reports of their standards, customs and experiences.

The replies of several roads which gave full information follow. Special attention is called to the full detailed descriptions of the Santa Fe, Canadian Northern, Chicago & Northwestern, Rock Island, Illinois Central, Missouri Pacific, New York Central, Northern Pacific and Pennsylvania railroads.

C. E. Smith, Chairman,
A. Ridgway,
W. A. Pettis,
G. A. Manthey,
G. S. Kibbey,
J. F. Parker,
Committee.

APPENDIX.

Extracts from letters received in response to a circular letter sent by the chairman to a number of railroads for information pertaining to ice houses and the storage of ice:

Atchison, Topeka & Santa Fe Ry.

A letter received from Mr. J. F. Parker, general foreman of bridges and buildings of the Santa Fe describes in brief a 30,000 ton ice house at San Bernardino, Cal., belonging to a commercial company. The house is kept cool by brine pipes and no loss in the ice is felt. The letter follows:

The abandonment of our old ice houses at San Bernardino followed the erection of the Gate City Ice & Precooling Plant, which is claimed to be the largest plant of its kind in the world. The entire structure is built of reinforced concrete with the walls and partitions insulated with 5½ in. of Nonpareil cork board. This plant is equipped with the most modern machinery. It has a manufacturing capacity of 225 tons of ice per day, a storage capacity of 30,000 tons and a platform capacity for placing 60 cars at a time, requiring 2½ minutes to place five tons of ice aboard each car.

This plant has six storage rooms, four of which are 65 ft. x 115 ft. x 42 ft. high, and two storage rooms 100 ft. x 132 ft. x 10 ft. high; also a dock storage room where ice is assembled ready for the platforms, 50 ft. x 132 ft. Ice is stored on edge, solid, and no insulation of any kind is used. The space between the ice and the walls is one foot, and the space between the ice and the ceiling three feet. Temperature is maintained by brine circulation. The size of the ice cakes is 11 in. x 22 in. x 44 in. and they weigh 300 lbs. There is no shrinkage.

The ice is handled by endless chain elevators and conveyors and by vertical elevators below the level of the icing platform. The icing platforms, four in number, are 700 ft. long and are roofed over. The ice is handled by endless chain conveyors from the dock room along these platforms.

In precooling cars, air at a temperature of 10 deg. is forced through them for four hours. From 12,000 to 15,000 cars are precooled and iced each season at this plant.

A letter received from C. F. W. Felt, chief engineer of the Santa Fe, states that the railway company has no brick or concrete houses of its own, all being of frame construction, and points out in great and satisfactory detail the practice of that road. His remarks about the use of waterproof paper instead of sawdust, cork, hay or strips of wood to prevent air currents among the cakes of ice and decrease the shrinkage are very interesting. The letter is as follows:

The rooms are built in bin size in multiples of 33 ft. 7 in. x 33 ft. 7 in. inside measurement, with wall plates 20 ft. above the floor. The capacity of the bins is 500 tons. The sills are 10 in. x 10 in. and are carried on creosoted pile heads. The foundations under the walls are of cinder fill with earth about 1 ft. deep at the outside wall line and sloping to the center of the bin 2 ft. in depth, with a length of drain pipe set in the ground, and a cinder bed packed on this cut.

The insulation of the walls is of frame 2 in. x 6 in. studding, with two thicknesses of ⅞ in. x 6 in. tongued and grooved sheathing, with asphalt paper between for inside lining. The exterior studding has the same insulation and is stripped with 1½ in. x 2 in. strips and two more thicknesses of ⅞ in. sheathing and paper, the exterior boarding being the finished wall covering.

The ceiling is of 2 in. x 6 in. rafters with two thicknesses of ⅞ in. boards and paper at the top and bottom of the rafters. The roof rafters are 2 in. x 6 in. with ⅞ in. boards covered with fire proof roofing. The roof has a ¼ pitch with one-half the space for air chamber and one vent to each bin.

An unloading automatic air drop at Fresno handles 7 blocks per minute, and the gig hoist 2 blocks per minute. These are single cake machines. At Stockton, 200 cakes weighing 300 lbs. each are handled per hour, while at LaJunta 30 tons of ice per hour are handled for each elevator and there are two elevators.

At Fresno and Stockton each block is stored close to the other, with every other tier crossing. The storage rooms are refrigerated. At LaJunta and Las Vegas natural ice is stored in insulated houses without refrigeration. The ice is packed closely with every other tier crossing.

All artificial ice is made into cakes of 300 lbs. each. Natural ice varies in size, the cakes being 22 in. square, the weight depending upon the thickness. They are usually 16 in. to 20 in. thick and average about 175 lbs. in weight. All ice is stored on edge under refrigeration with no space between cakes. Ice is packed in insulated houses with the cakes placed as closely together as possible without touching. The cavities between the ice and the walls vary. With artificial ice under refrigeration, this is usually 12 in. to 18 in.; with natural ice packed without refrigeration in insulated houses, 6 in. to 18 in. The space between the ice and the ceiling is usually three to four feet.

No insulation is used in refrigerated houses. When ice is packed without refrigeration no insulation is used except between the ice and walls and on top.

We have experimented with strips of wood between layers of ice and found it to be unsuccessful. Placing paper between layers is now being tested at South Shawnee and Purcell. We experimented last season with one room at South Shawnee where artificial ice was being used and found the shrinkage materially reduced. The result of experiments this season at these two houses will probably determine the practicability of using waterproof paper between the layers of ice packed without refrigeration. The practice of using sawdust or other insulated material between layers was discontinued some years ago. The sawdust became frozen into the ice, making it almost impossible to wash the ice clean for use and resulted in heavy shrinkage after it was taken from the ice houses on this account. No experiments have ever been conducted with cork between layers of ice.

No covering is applied in case of ice held in storage under refrigeration. Ice packed without refrigeration is covered with one or two feet of sawdust or hay. We are now experimenting at the LaJunta house with layers of paper over the top tiers of two rooms, sawdust being placed on top of the paper.

In the case of ice stored under refrigeration it is immaterial as to the quantity removed from day to day. In the case of ice packed without refrigeration, if it is to be used during a short busy period, the best method is to remove all insulation covering, such as sawdust, hay, etc., in order that the ice may be kept as clean as possible and thus avoid heavy shrinkage from washing. Santa Fe houses are divided into rooms, the capacity of which is approximately 500 tons. The ice in each room should be entirely removed before the insulation or covering is removed from the top or around the ice in the room next opened.

In the case of ice stored under refrigeration there is no shrinkage. The shrinkage of ice packed without refrigeration varies in accordance with the construction of the storage rooms so far as insulation, etc., is concerned and the time required in removing ice as used. The average shrinkage on the Santa Fe is approximately 25 per cent, although this will vary somewhat from year to year.

In all cases ice is taken out of the houses ahead of the trains so that on arrival cars may be reiced immediately.

Boston & Maine R. R.

The following letter from Mr. A. B. Corthell, chief engineer of the Boston & Maine, sets forth the practice of that road as exemplified in the construction of its 6,000 ton wood frame ice house at Mechanicsville, N. Y. This road has no brick or concrete ice houses.

This house has five rooms 32 ft. x 60 ft. with a capacity of 1,200 tons each. The foundations under the walls and partitions consist of concrete piers.

The floors consist of a cinder fill with loose boards on top for the ice to rest on. The walls are double studded, sheathed on the inside and filled with shavings. The partitions are single stud, sheathed on one side only. The ceiling is 3 ft. above the plate. It is a single matched floor on the ceiling joists and has about 1 ft. of hay on the floor. The roof is flat, with no insulation. The average height of the attic is 8 ft., with no insulation.

The size of cakes of ice is 24 in. x 30 in. The cakes are stored flat, with 3 ft. between the ice and the ceiling. The ice is not covered.

This house is used only for icing refrigerator cars. The ice is brought to the building in cars. The house is filled from the rear by means of adjustable galleries. Ice is taken out of the house by skip hoists leading up to the crusher room. It goes through an ice crusher and discharges into push carts. The carts are wheeled out onto a platform which is considerably higher than the top of a car and the ice is dumped through chutes into the car. Cake ice is also put into the cars from this platform.

There is a salt house in connection with this building. The salt is shoveled out of the car into a hopper and is conveyed up into the salt house. It is then shoveled from the house into carts and dumped into boxes suspended at the edge of the platform at convenient distances. The ice and salt are mixed as they are put into the car. All machinery is driven by electric power. The cost of this house with machinery was $25,000 which is at the rate of $4.16 per ton of storage capacity.

Baltimore & Ohio R. R.

The Baltimore & Ohio has built no ice houses recently but described in brief a brick house of 6,000 tons capacity to be located at Cumberland, Md. A letter from Mr. F. L. Stuart, chief engineer, is as follows:—

We have built no ice houses recently and, for this reason, we cannot give you the detailed information you desire; however, we have prepared plans for an ice house to be located at Cumberland, Md., to hold 6,000 tons.

We would recommend that ice be taken from the main room to a crushing room, and there placed in the barrows for delivery after cars have been placed. On account of the loss in hot weather, I would recommend that most of the barrows be kept inside the house until the cars have been placed ready for filling.

The house is divided up into rooms of about 450 tons capacity each. The elevators are enclosed to keep the outside air from the room while the elevators are in operation. Each elevator serves two rooms.

The only important detail in regard to the drainage is to have a trap in the line, so that the air from the sewer will not back up into the house.

A feature of this house is the two-story platform for loading ice into the cars—the lower one being used for cakes, as they will slide readily, and the upper or high platform being used for crushed ice. The platform on the level of the car floor is for receiving artificial ice to be loaded into the ice house.

We estimate that this house will cost $40,000, which at 6,000 tons capacity, would be $6.66 per ton of space occupied.

Canadian Northern Ry.

The Canadian Northern, through its architect, Mr. R. B. Pratt, submitted an excellent description of their practice. Their ice houses are all of frame construction.

A copy of Mr. Pratt's letter and of the instructions follow:—

The ice houses at present being built by the Canadian Northern Railway are of the following standard capacities and sizes:—

100 tons capacity	24 ft. wide x	20 ft. long x	18 ft. high to eaves of roof
150 " "	24 " " x	26 " " x	18 " " " " " "
250 " "	24 " " x	32 " " x	18 " " " " " "
500 " "	24 " " x	62 " " x	18 " " " " " "
800 " "	24 " " x	92 " " x	18 " " " " " "
1000 tons capacity	24 ft. wide x	123 ft. long x	18 ft. high to eaves of roof
1500 " "	24 " " x	183 " " x	18 " " " " " "

The foundations consist of 8 in. x 10 in. longitudinal sills at the sides with 8 in. x 8 in. cross sills every 15 ft. and at the ends. These sills rest on wood blocking at about 5 ft. centers. The floors consist of a filling of about 18 in. of cinders or gravel well tamped and covered with 12 in. of sawdust.

The outside walls are built up of 2 in. x 10 in. studs at 2 ft. centers with the necessary girths and plates. They are covered on the outside with ⅞ in. surfaced sheathing, 2-ply "Hercules" insulating material and ⅞ in. drop siding, and on the inside with 2-ply "Giant" insulating material and ⅞ in. shiplap. The walls are filled between the studs with sawdust thoroughly compacted. The larger ice houses are divided by cross partitions with sections of equal capacity as follows:—a 500-ton house 2 sections, 800-ton 3 sections, 1,000-ton 4 sections, 1,500-ton 6 sections. The partitions consist of 2 in. x 4 in. studs at 2 ft. centers, with shiplap on both sides and with openings in the center 4 ft. wide x 18 ft. high to take ice through from one section to the other.

The ceilings are of ⅞ in. shiplap secured to 2 in. x 6 in. ceiling joists at 2 ft. centers; these are braced and spiked to rafters. The upper side of the shiplap is covered with about 8 in. of sawdust. Hinged traps are provided in the ceilings at intervals for ventilation purposes. The roofs are built with ⅞ in. sur sheathing secured to 2 in. x 8 in. rafters at 2 ft. centers, and are covered with 2-ply "Paroid Ready Roofing." A one-third pitch is adopted in every case. Louvre ventilators 4 ft. x 4 ft. x 3 ft. high are placed in the roofs of the various ice houses as follows:— 100-ton 1 vent; 150-ton 1 vent; 250-ton 1 vent; 500-ton 2 vents; 1,000-ton 4 vents; 1,500-ton 6 vents.

In order that the ice houses may be filled to their capacity, chutes are located in the ceilings at the ends where the large doors come and for which separate doors are provided. As much ice as possible is brought in through the large doors and the final filling is done by way of the separate doors and chutes. Large insulated doors for taking in the ice are located at the ends of the ice houses. The doors are divided into three sections with separate doors above to the chutes. The 100-ton, 150-ton and 250-ton ice houses have only one large door; in all others there are two. Insulated doors are provided in all ice houses to the vestibule and from the upper floors of same to the large icing platforms. Small insulated side doors are provided on the main-line side of all ice houses, one to each with the exception of the 1,500-ton ice houses, which have two. All doors are insulated in a manner similar to the walls.

Windows are provided in the larger ice houses only as follows:— 800-ton 1 window; 1,000-ton 2 windows; 1,500-ton 4 windows; the windows consist of three separate sashes each with 9 lights 10 in. x 10 in. with a 1 in. space between the sashes.

Platforms 3 ft. wide extend the full length of the ice houses on the side from which the cars on the siding are iced. For any occasional icing that may be required for cars on the main line, platforms 3 ft. wide x 5 ft. long are provided opposite the small insulated side doors. All ice houses are provided with one of these small platforms with the exception of the 1,500-ton houses which have two.

Vestibules are provided at one side of the end of all ice houses, one to each house. The ice is taken into the vestibules through openings 3 ft. wide x 16 ft. high in the wall of same. These openings are filled with boards which can be slipped out to whatever height the ice may be in the ice houses. The vestibules have lower and upper floors, the

upper floors being level with the large icing platform. Elevators operated by hand winches located on the outside of the ice houses elevate the ice from the lower to the upper floors of the vestibules when it cannot be taken directly through the slip-board openings to the upper floors.

The ice houses are packed in the month of March with natural ice in blocks measuring about 18 in. x 18 in. x 30 in. A space of from 6 in. to 9 in. is left between the ice and the walls. The ice is built up to about 12 in. from the ceiling without wood strips or sawdust between the layers.

Chicago & Alton R. R.

The practice of the C. & A. in frame construction (having no concrete or brick houses) is set forth in the following letter from H. T. Douglas, Jr., chief engineer, descriptive of their 15,000-ton ice house at Roodhouse, Ill.:—

The size and capacity of the rooms are somewhat variable, but the approximate size is 44x64 ft. in plan. The foundations under the walls are of concrete. The foundations under the floors consist of a layer of cinders and those under the partitions of concrete or cedar posts. To insulate the floors a layer of straw is placed on an 18 in. cinder layer on top of which a 2 in. plank floor is laid.

The type of outside wall from the outside to the inside in successive courses consists of ¾ in. siding, a double layer of Neponset black insulating paper, 13-16 in. sheeting, a 4 in. space filled with sawdust with 2x4 in. spacers 24 in. centers, a double layer of insulating paper, 13-16 in. sheeting, a 10 in. air space with 2x10 in. spacers located 24 in. centers, 13-16 in. sheeting, a double layer of paper, 2 in. furring strips, a double layer of paper and 13-16 in. sheeting.

A type of partition consists of 13-16 in. sheeting, a double layer of paper, 13-16 in. sheeting, a 10 in. air space with 2x10 in. verticals and spaced 24 in. centers, 13-16 in. sheeting, a double layer of paper, and 13-16 in. sheeting.

Ceiling joists are floored with 2 in. dressed and matched material. One layer of paper is sometimes placed between the sheeting and the under side of the rafters. The rafters are covered with ⅞ in. sheeting, then one layer of paper and then roofing material.

The ice stored this year was 22 in. square and averaged from 8 to 16 in. in thickness. It was stored on edge with no space between cakes. The ice was placed against the side walls and close to the ceiling and without insulation for the ice. We used no wood, paper, sawdust or cork between the layers nor any covering on the ice.

The percentage of shrinkage at this house in 1913 was approximately 30 per cent. The ice is distributed along the platform just before the arrival of trains.

Chicago and North Western Ry.

The practice of the C. & N. W. Ry. is well set forth in the following reprint of an article that appeared in the Railway Age Gazette of May 15, 1914, by Mr. L. J. Putnam, principal assistant engineer of that road, descriptive principally of the facilities at Clinton, Iowa, and Green Bay, Wisconsin:—

Late in 1912 the Chicago & North Western decided to greatly enlarge and improve its car icing facilities at Clinton, Iowa, and the writer, as division engineer at the time, was called upon to furnish plans and carry out the work. More recently a similar plant of smaller capacity has been provided at Green Bay, Wis. The small amount of information on this subject available in engineering literature indicates that a description of these very necessary railway appliances as installed at these two locations will be of interest. As both plants are similar, they will be treated together, calling attention to special features at either location.

Clinton, Iowa, is the heaviest car icing point on the North Western system, all through fruit and meat cars being inspected and iced there

as necessary. As high as 140 cars per day have been iced at this point during warm weather. Previous to 1913 no modern equipment for car icing was in use at Clinton or any other point on the system. The old house was a 15,000 ton structure which had been enlarged from time to time as the business made it imperative, but no machinery for handling had been provided and ice below the level of the car roof had been hoisted by horse power to the platform.

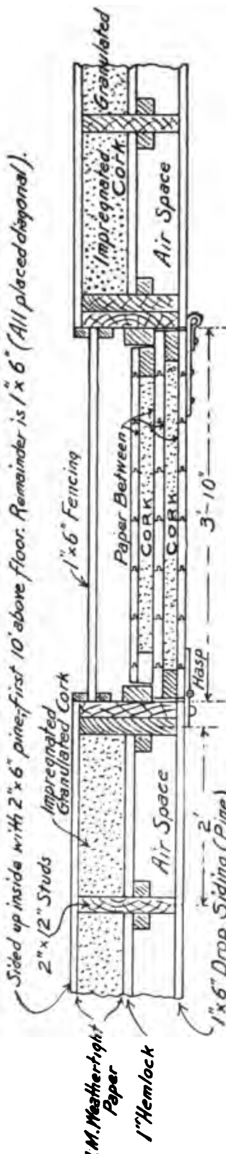
The house was located about two miles from the Mississippi river, the only available ice field, but at the most convenient point for icing cars as it was served by a track parallel to the main line where through trains could conveniently pull through the siding for inspection and icing without interference with other traffic. Because of the necessity of cutting down delays to through trains it had been necessary to keep a large supply of ice distributed the full length of the platform all the time. This necessitated using ice from nearly all the rooms in the house at one time and exposing all to the warm air. The long time that ice lay on the platform, because of the slow rate at which it could be brought out by the horse hoist, also resulted in excessive shrinkage. As a result of all these conditions it was a usual occurrence to run short of ice during the latter part of the season and be compelled to buy in the outside market at high prices and ship in cars with still further great shrinkage losses.

To eliminate these objectionable conditions and to effect the greatest economy, machinery for rapidly handling the ice both into and out of the house was desired in connection with the doubling in storage capacity from 15,000 tons to 30,000 tons. Unfortunately the old house was located in a 20 ft. cut extending back to an important street so that the width of the house was limited to 50 ft., necessitating a total length of 950 ft. to obtain the desired capacity. While contributing largely to the first cost of the house this great length is an advantage in permitting a long train of cars to come to the platform at one time, though a considerably shorter but wider and higher house would have been decided upon except for the natural limitations referred to. The Green Bay house with a width of 63 ft. is much to be preferred where space is available.

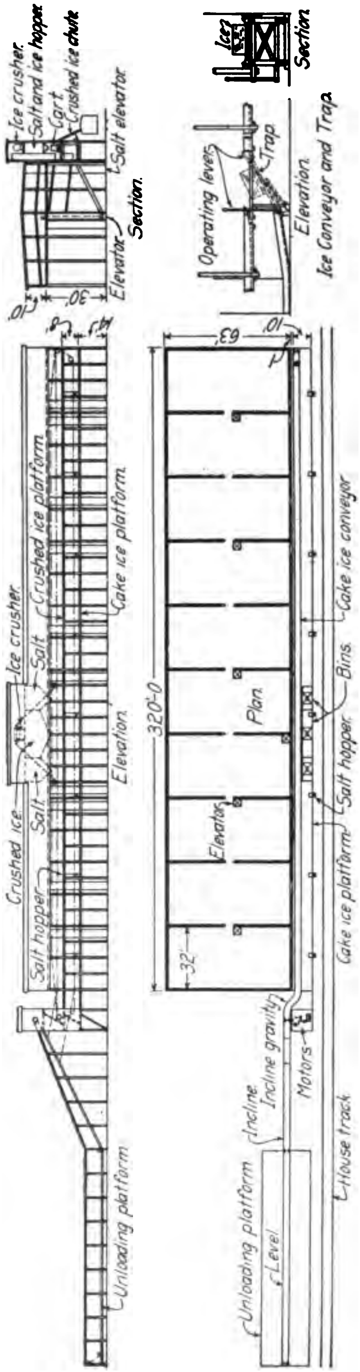
Car icing at points like Clinton and Green Bay is divided between meat cars requiring the use of crushed ice in the bunkers and fruit cars requiring only cake ice, the difference being, of course, that a temperature sufficiently low for meat cannot be maintained with cake ice. This fact necessitates means for crushing and for handling both crushed and cake ice at the same time to the same train which is being served at the platform. All cars also require salt with the ice.

Construction of the Houses.

The accompanying plan of the Green Bay house shows the general arrangement of the house and machinery, but does not show the details of the building. This house is 63 ft. wide by 320 ft. long and is divided into ten rooms approximately 31 ft. by 61 ft. The side walls are composed of 2 in. by 12 in. studding spaced 2 ft. center to center. Dressed and matched sheeting 2 in. thick for the lower 10 ft. and 1 in. thick above this is used on the inside placed over building paper. On the outside, 1 in. drop siding is used, also over building paper. The single dead air space thus formed is divided by a partition of 1 in. dressed and matched sheeting nailed to cleats on the studs. The inside one of the two spaces thus formed is filled with granulated cork. The walls thus consist of three thicknesses of dressed and matched lumber, two thicknesses of paper, one 6 in. dead air space and one 5 in. space cork filled. Partitions between rooms are of 2 in. x 12 in. studding, sheeted on both sides. The roof is supported by four lines of light roof trusses having wooden top chords and rod tension members for the lower chords. Jack rafters on the trusses support a covering of sheathing and prepared building paper. A light ceiling of 1 in. sheathing is suspended from the trusses, forming



PLAN AT DOOR
SECTION OF OUTER WALLS.



Plan and Elevation of the Northwestern Ice House at Green Bay, Wis.

a dead air space of the depth of the trusses above the ice. Ventilators are provided for each room.

The construction of the Clinton house is somewhat less expensive. There the rooms are 25 ft. x 50 ft. Side walls are built up of 2 in. x 8 in. studding with 1 in. shiplap inside and out. After covering the outside sheathing with building paper, 2 in. x 4 in. strips were nailed vertically 2 ft. apart. Another layer of paper and drop siding over this completed the wall, providing in all, three thicknesses of matched sheathing, two layers of paper and two dead air spaces. With these arrangements for walls no sawdust is used, but the ice in one-half of the house is covered with about 1 ft. of marsh hay and is reserved for the latter part of the season. The marsh hay provides a satisfactory protection and when removed leaves the ice clean.

No floor is provided, but old bridge ties removed during the regular bridge repair work are laid down with 8 in. spaces between, covering about 50 per cent of the area and affording a chance for the water to settle below the ice and pass away into the sand. At Green Bay drain tile are laid beneath the ground to remove the water, but this was not found necessary at Clinton, where the material was dry sand.

An outside waling timber is used at about the mid-height of the house with rods projecting through at each partition. This same wale serves to support the platform joists on the front of the house.

Platforms.

The lower platform, which is used exclusively for cake ice, is 14 ft. above the top of rail and is 10 ft. in width. The upper platform for handling the crushed ice and salt is 22 ft. above the top of rail. An upper or third story of the platform near the middle accommodates the ice crusher and the hoppers for ice and salt. The space underneath the lower platform at this point is enclosed for salt storage.

Both platforms are tightly enclosed with continuous sliding doors on the track side so that an opening can be made opposite car bunkers at any point. When no icing is being done the doors are kept carefully closed, excluding the warm air. The upper platform is made as nearly water-tight as possible by using 2 in. plank provided with a caulking edge and caulked with oakum; otherwise the leakage would greatly discomfort workmen below.

House Machinery.

The cut indicates in a general way the kind and arrangement of machinery at the Green Bay house, the arrangement at Clinton being similar. It was at first thought desirable to install the usual type of adjustable gallery conveyor for filling the house, as this has some advantages over any other type for that purpose. It could not, however, be utilized for emptying the house, so it would be used only for a few days during the year. It could not be installed on the front of the house without interfering with the platforms and if installed on the back it would be inconvenient to serve it from cars. It was therefore decided to use one set of machinery on the platforms for both purposes, adapted as far as possible to both uses. The plan adopted has proven economical for both.

The platform conveyors consist of one endless, double chain conveyor with 36 in. oak hold bars every six feet traveling on wooden slides of hard maple. Both runs of the chain are thus used for conveying ice and by making the machinery reversible, ice from any point can be delivered anywhere along either platform.

In filling the house ice is delivered to the chains by inclined conveyors at the end. At Green Bay only one incline conveyor is used, and of course ice can be delivered only on one platform conveyor at the same time. This is satisfactory there, as the ice harvesting season is long and the work is not crowded. At Clinton, where a capacity of from 1,500 to 2,000 tons per day is packed in the house, it is necessary to

provide an incline with an unloading platform at each end. The incline serving the lower platform conveyor is low and not requiring a great deal of power is operated by a sprocket chain from the hoist that runs the platform conveyors, eliminating separate driving machinery. The incline conveyors are necessarily offset to one side of the platform conveyors on account of the impossibility of delivering ice through the running chain. An "S" shaped slide automatically delivers the cakes from the incline to the horizontal conveyors.

All conveyor chains have offset eye links for receiving the ends of the cross bars, or hold bars. This makes the upper conveyor chain "right" side up so that the cakes of ice can be passed over the chain without interference and the upper slide was at first located on the platform. The lower conveyor chain is necessarily reversed or "wrong" side up and as the cakes could not be passed over the chain conveniently this slide was suspended about 30 in. above the platform and traps were provided in the slide at each door of the house so that the cakes are dropped through. By using a 90 deg. circular chute they are delivered directly into the doors of the house.

During the warm season the cake ice is distributed along the platform in the same manner, making the entire surface of the platform available for ice. The conveyor is also up out of the way where the men cannot accidentally slip or fall into it and possibly receive injury. On account of the advantage of a suspended slide, as shown by use of the lower conveyor, the upper conveyor was later changed to a suspended position similar to the other. The arrangement for traps in the slides is a simple affair made by the carpenters on the work and is shown in the drawing. The upper conveyor is raised temporarily to top out the house, as indicated in Fig. 1, after the house is nearly filled. The raising of the conveyor is only a small matter, as it is built with this in view and the work can be done by a few carpenters after work hours without delaying the packing.

Two lowering slides are provided to ease down the cakes of ice to avoid breakage inside the house. These are light affairs readily moved about and consist of light frames carrying conveyors. A band brake on the upper shaft controls the speed. These lowering slides are used only for a few layers when the drop is greatest. Simple slides shifted about to deliver the cakes close to the packers are used otherwise. At Clinton when the lower three layers are placed directly from the cars no mechanical lowering slides are used.

The difficulty of lowering the ice into the house and the danger of breakage was considered a strong argument against the type of machinery adopted and was condemned rather strongly by the company manufacturing the machinery. The plant in operation showed that such fears were largely overestimated and the results have justified the arrangement adopted.

For emptying the rooms of ice below the level of the lower conveyor, gig elevators are installed at the Green Bay house. Ice above the lower conveyor is of course readily removed by gravity. One gig serves two rooms and a 2 h. p. motor in the loft furnishes the power. Light slides are used from the gig shaft to the front doors of the house, delivering the ice cakes automatically to the chain conveyors. The gig machinery with the exception of a few fixed parts is moved from one location to another as the emptying progresses, economizing on the amount of machinery required.

To take the ice from the field at Clinton and load it into cars for transportation to the house, a double chain conveyor similar to the others described and also motor driven is used. This has an incline elevating about 40 ft. above the water and a level run of 600 ft. alongside the loading track. The level portion is on a platform about 3 ft. above the floor of a car so that three or four tiers of ice can be run into the car by gravity. Ten to twelve cars are spotted at one time and about one-half are loaded simultaneously.

The motors at Clinton are all direct current, using power from the street railway company, excepting the one motor at the river, which is driven from a generating plant which operates the draw-bridge. The motor driving the horizontal conveyors and the first story incline at the house is 30 h. p., the motor on the high incline is 10 h. p., the gig motor is 2 h. p. and the motor at the river is 20 h. p. The 30 h. p. motor is perhaps larger than necessary as the load when running is only about 10 h. p. Starting the chain when loaded or when slightly frozen makes it advisable to have ample capacity.

Ice Crusher and Salt Elevator.

The ice crusher is placed in an elevated house as shown, sufficiently high that the crushed ice drops into a bin and is hoppered to an outlet three feet above the upper platform, high enough to deliver into the boxes of two-wheeled dump carts which are used for handling the crushed ice. A salt hopper adjoining is provided with a similar outlet so that when a cart is loaded with ice it is pushed along to the salt hopper and receives the necessary proportion of salt. Both the ice crusher and salt conveyor are operated from the same motor. The motor used is the 10 h. p. motor employed during the filling season at the high incline. The salt elevator is a simple bucket and chain affair loading from a boot at the ground level and discharging into the salt bin above. For the charging conveyor to the ice crusher the upper platform conveyor is carried up over an incline to raise the ice to the necessary elevation, as shown. Idlers are used at the angles in the chain as elsewhere.

Harvesting the Ice.

The Clinton ice field is on the Mississippi river at a place with only a sluggish current, but enough, nevertheless, to require prolonged zero weather to freeze ice of suitable thickness for packing. The size of the field is also limited, containing only about 20 acres. With 12 in. ice, the minimum considered advisable to cut, only about 20,000 tons is available from the entire field. Usually the thickness increases so as to make up part of the deficiency and ordinarily a part of the field can be re-cut. Under exceptionally unfavorable conditions a certain amount of ice has to be cut elsewhere and hauled in by trains.

The field is watched closely after it freezes over and all snow possible is scraped off by teams. This not only prevents snow ice, but removes the snow blanket which would greatly retard the further freezing. The field is exposed to the sweep of the wind and rarely accumulates snow unless it is very wet. The removal of snow is therefore a small item ordinarily.

Cutting is started with ice of 12 in. thickness. Plows are used. cutting both ways as deeply as the ice will stand. Cakes are cut 22 in. square, as the size seems preferable for car icing, though much smaller than is used in ordinary commercial houses. Two cakes of this size can be delivered to each hold-bar on the conveyors, so that the handling is as rapid as with cakes double the size, but the cutting is considerably more expensive. As the hold-bars are spaced 6 ft. apart and the chain runs at 100 ft. per minute the two cakes per bar means 33 cakes per minute, which, with 12 in. ice, aggregates 2.8 tons or 1,680 tons in 10 hours.

This rate, of course, cannot be steadily maintained and 1,000 tons in a nine-hour day is considered a good day's loading. Night loading is resorted to if the lateness of the season and the condition of the ice seem to justify pushing the cutting to the limit. Ice loaded at night is held until day, as the capacity for packing is greater and the entire output can be put into the house by the day shift working a little overtime if necessary. The house is well lighted by electricity. Cluster lights on portable poles are used on the ice field in sufficient quantity to make the night work almost as economical and safe as the day work.

The ice cakes are handled flat until delivered in the packing room.

There the cakes are turned on edge by the tongmen doing the packing. The small size of the cakes makes this easy and the varying thickness of ice makes no difference with the tiers in the house. Each tier of ice contains the same tonnage, which is of some help in removal. If the cakes were packed flat it would be necessary to trim them to the same thickness at the field conveyors. This would waste much ice in any case and as the thickness was increased from day to day would make continual trouble in packing. A car not switched in regular order would come in with thicker ice, making uneven layers. It was therefore concluded best to omit the trimmer and pack on edge.

The filling at the Clinton house is handled in the following manner: As many cars as can be accommodated at the two platforms (five at each) are spotted and unloading is done as rapidly as possible. Four men on each platform load the conveyor, each man loading a cake on every fourth hold-bar in regular order. If two cakes per bar are being handled the number of men is doubled. Each man thus has exactly the same work to do and performs it with clock-like regularity. A small amount of ice accumulates on the platform by the time the cars are emptied, which will keep the conveyor busy while new cars are being spotted so that a continuous supply of ice is delivered to the conveyors.

As the lower three tiers in the rooms are placed by gravity directly from cars, a small start is made in this way the first day while the field is being opened up and the organization perfected before the conveyors are in use. With the work under way four rooms are being filled on each lift simultaneously. The ice delivered to each conveyor is therefore divided in distribution to four points. Three men on the platform operate three traps serving the rooms, the fourth trap farthest from the platform simply being left open. Each man drops the cakes from every fourth bar through his trap, distributing the cakes equally to the four packing crews on each level. Inside the rooms sufficient men are employed to keep the slides arranged and remove and pack the cakes as they come in. Plenty of sub-foremen and a few extra men are always found economical, as a few minutes' blockade and delay to the conveyors will more than offset the expense.

No chip conveyor has been installed and the first season's work did not indicate that such would be necessary. A few chips accumulated on the platform and in the cars, but only very few reached the conveyors. A slatted section of the slide at the receiving point on both horizontal conveyors let the chips fall through, but the quantity was so small that they accumulated under the lower platform and did not have to be removed.

Emptying the House.

Emptying the house while comparatively slow is also equally simple. All ice down to the level of the lower conveyor is removed by gravity. Below that point it is elevated by the gigs to the slides serving either conveyor as desired. The icing crew fills the crushed ice bin and distributes cake ice along the lower platform between trains, running the conveyor in the direction required to serve the room being emptied. The crew is then ready for the quick despatching of cars as they are spotted at any point along the length of the platform. A small crew can be kept busy all the time without any considerable delay to traffic. Small salt boxes are located on the front of the lower platforms, as shown, so that where cake ice is being used the man on the car can take from the box with a scoop shovel what salt is necessary. These small salt boxes are filled through a fixed chute, opening on the upper platform. Salt from the central bin is wheeled to these chutes and dumped to fill the boxes below.

Sheet iron chutes hung by hooks are lowered from the upper platform to convey the crushed ice into the bunkers. These are light and are transferred from point to point as needed. Light wooden slides are used for running the cake ice into the bunkers.

Cost of the Ice Harvesting.

As yet only one harvesting season has passed since the erection of the Clinton house and this one season was the most unfavorable known for many years. The field was entirely open until late in January, when a few cold days made ice of 10 in. thickness. It looked then as though but little might be expected there and cutting was started on the 10 in. ice. After two or three days the weather again moderated and a rain made it necessary to suspend work and discharge the crews. After two weeks of waiting another cold period put the field in workable condition with 12 in. ice and packing was again commenced. Fortunately the weather continued cold for several days and the ice thickened to 14 in., the heaviest of the season. A night cutting crew was put on and the work rushed to the limit. Teams were also engaged and a small field farther down the river, but near the house, was cut over. About 8,000 tons was obtained in this way. One train load was also shipped in from the north. Under all of these adverse conditions the cost was necessarily high. The organizing of two virtually new crews made a large item of expense, as did also the effort to put up thin ice on a flooded field. Including all expense for train service, current, etc., the ice handled on cars cost 52 cents per ton, packed in the house. With average conditions this should be reduced from 25 to 40 per cent.

Chicago, Burlington & Quincy R. R.

The C. B. & Q. R. R. Co., through its engineer of buildings, Mr. W. T. Krausch, offered the following reference to their 17,000 ton ice house at Galesburg, Ill.:—

This plant cost approximately $2.70 per ton and the capacity is 17,000 tons. The shrinkage is less than 5 per cent. The house is insulated, the insulation consisting of 6 in. sawdust, a 12 in. air space and 2 in. lith blocks.

We have also constructed ice houses of a cheaper type, using 12 in. of sawdust for insulation with 2 in. lith blocks. The shrinkage in this type of house varies from 14 to 24 per cent. A still cheaper type consists of using mineral wool and sawdust, and for this particular type of house the shrinkage varies from 21 to 30 per cent. The cost per ton of the ice houses varies a great deal, depending entirely on the insulation and the size of the house.

Chicago Great Western R. R.

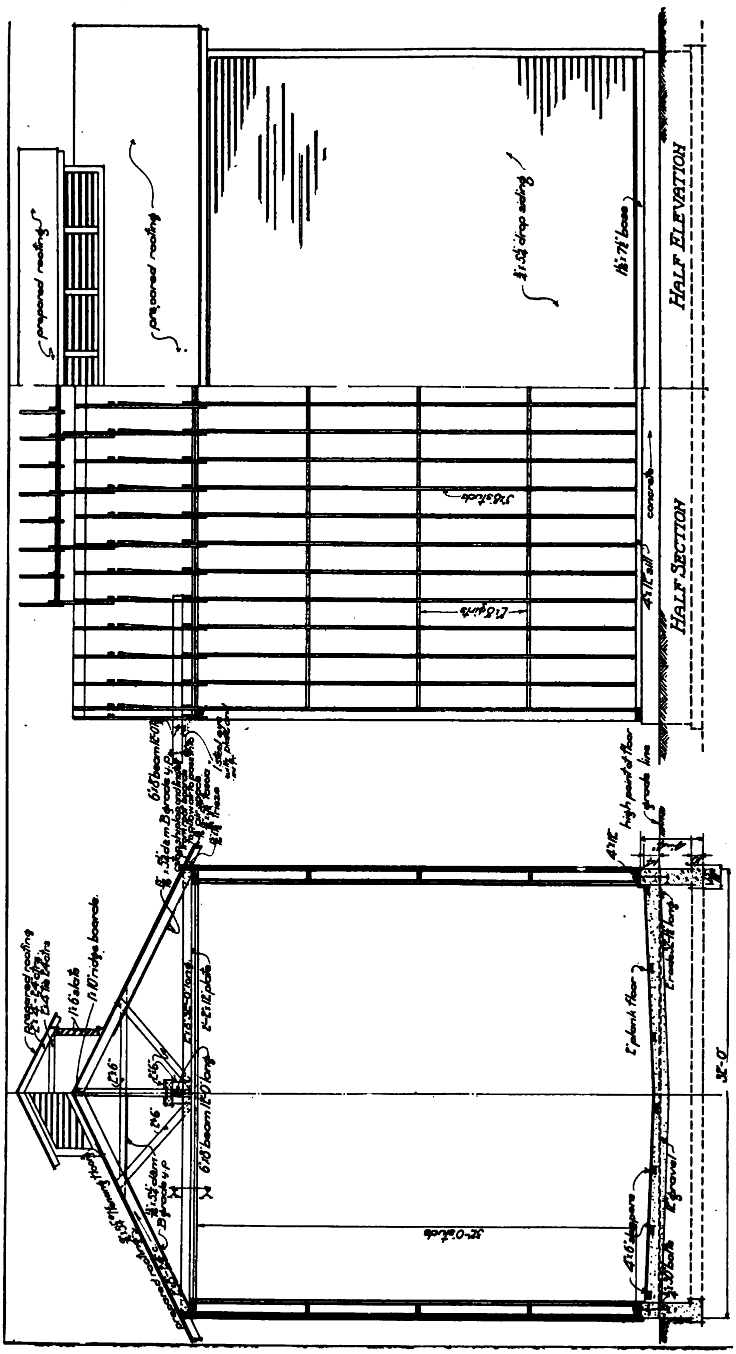
The practice of the Chicago Great Western is set forth in the following letter from its chief engineer, Mr. C. G. Delo:—

We have standard plans for 600, 1,500 and 2,000 ton ice houses, the rooms varying in size, according to the capacity desired. The construction is as follows: concrete foundations, clean gravel and broken stone foundations under the floors and concrete foundation under partitions. No insulation of floors is provided.

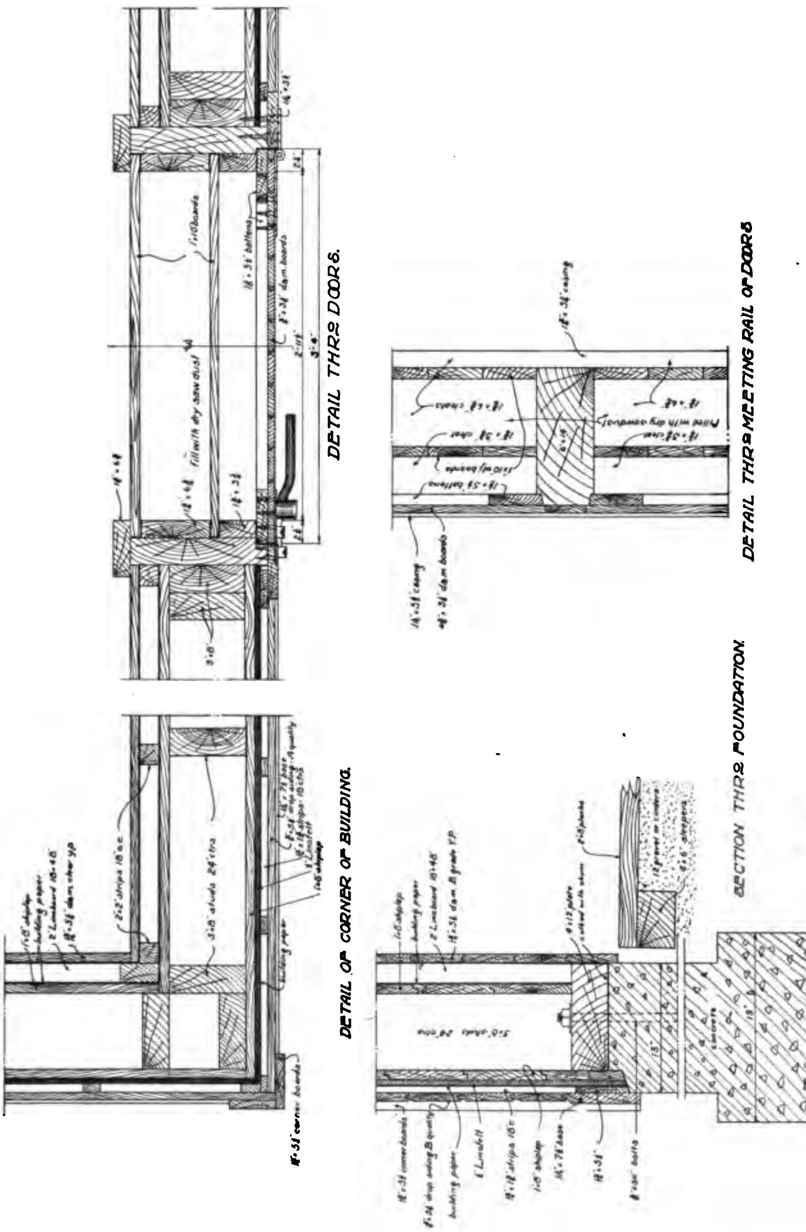
The walls are of 12 in. studs; next to the studs on the outside is 1 in. sheathing, then one layer of building paper, then furring strips and air spaces; then drop siding. On the inside there is first 1 in. sheathing, then building paper, then furring strips and air spaces; then ⅞ in. matched fencing put on horizontally.

In storing the ice no spaces are left between cakes, the ice being piled solidly. The cavity between the ice and the walls, a few inches wide, is filled with sawdust.

The roof construction is as follows: The rafters are covered on the upper side with 1 in. matched roof boards over which is laid a 4-ply asbestos roof. The underside of the rafters is ceiled with ⅞ in. matched fencing, thus leaving an 8 in. air space between the ceiling and roof sheathing. The ice is not piled higher than the cornice and is covered with a layer of sawdust.



Ice House of 850 Tons Capacity, Chicago, Rock Island & Pacific Ry.



Details of 850-Ton Ice House, C. R. I. & P. Ry.

We have nothing showing the percentage of shrinkage but several houses recently built have been found very efficient in preserving the ice; much more so than our old ice houses,—and are very satisfactory. The houses cost complete from $2.50 to $3 per ton, according to difference in location and weather conditions.

Rock Island Lines.

Mr.. C. A. Morse, chief engineer of the C. R. I. & P., very fully described the practice of that road in wood frame construction as that road has no brick or concrete ice houses. The letter of Mr. Morse follows:—

The maximum capacity of the rooms should not exceed 2,000 tons. The foundation under the walls should be of concrete where the bearing of the soil will permit. The foundation under the floor should be cinders and that under the partitions should be of concrete the same as the outside walls.

In preparing the floors one should use at least 8 in. of good screened cinders with a minimum of 8 in. of sawdust, covering this with 2 in. plank so that ice may be easily handled. The floor slopes towards the line of farm drain tile installed to carry the water from melting ice out of the building.

With reference to the insulation of the walls and partitions, we have found that we get the best results by packing the space between the studding with dry sawdust, covering it with a first class insulated paper such as Bird's Neponset. Where we can afford it there should be two thicknesses of boards on both sides of the studding with a paper between. However we have gotten good results by putting paper directly on the studding with one thickness of the boards on the outside and one thickness of boards on the inside, using drop siding on the outside and lapped 1 in. x 6 in. lumber on the inside. The paper is so placed longitudinally that it does not interfere with putting in and packing the sawdust from the top. We generally use some waterproofing paint 6 or 7 ft. up from the bottom on the inside of the wood ceiling.

We have no insulation of the ceiling, but believe that it should be insulated. We find that the best method of insulating the attic is to put on a dressed and matched flooring over the collar beams, then lay 8 in. or more of dry sawdust over this.

We do not have any platform conveyor, but use trucks. We use Gifford-Wood Co. or Mechanical-Handlor Co.'s machinery. The rapidity and capacity of elevators or conveyors depends entirely upon local conditions. The cakes are 22 in. square and are stored flatways. We place the ice directly against the wall and just as high as we can work it, providing head room. We use sawdust for insulation of the ice. Hay is preferable but more expensive.

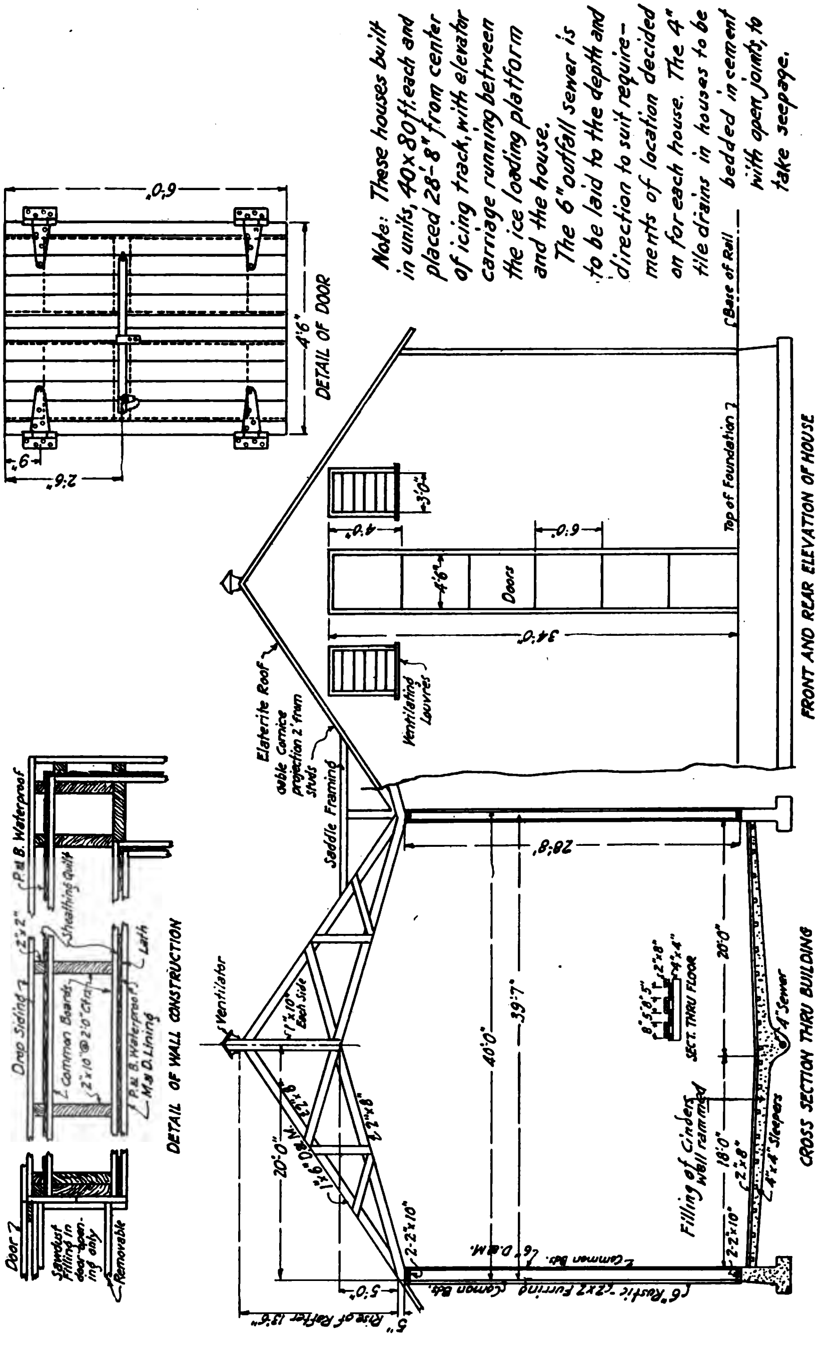
We do not store artificial ice.

We place farm drain tile in the cinders underneath the house and try to draw off all the water to a sewer outside, taking care, however, that the same is properly trapped so that no air gets back into the bottom of the house, as this is one of the things that raises havoc with the storage of ice. We can not furnish data in regard to shrinkage.

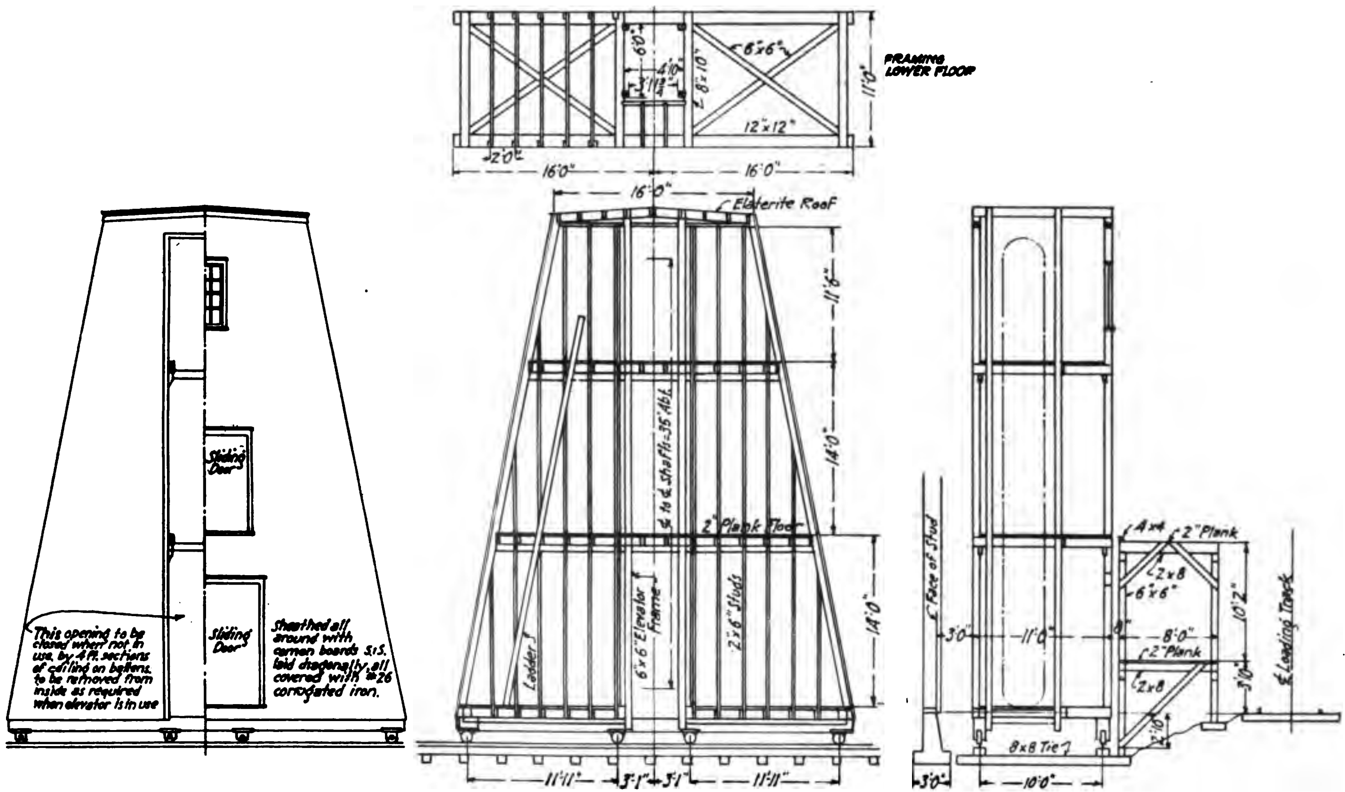
Practically every ice house is operated under different conditions. Some of our ice houses are not opened until August 15 when we start using ice. Others we take ice from the entire year.

We provide an ante room just off the elevated platforms which is insulated but not as much as the ice house. We place our ice in carts in this insulated room just ahead of the arrival of a train to be iced and only bring the carts out when the train has pulled along the platform.

Our Albert Lea, Minn., house, which holds 1,200 tons, cost $3,500 with elevating machinery and platforms. The cost of houses, of course, varies with the size. The smaller ones cost much more proportionately than the larger houses.

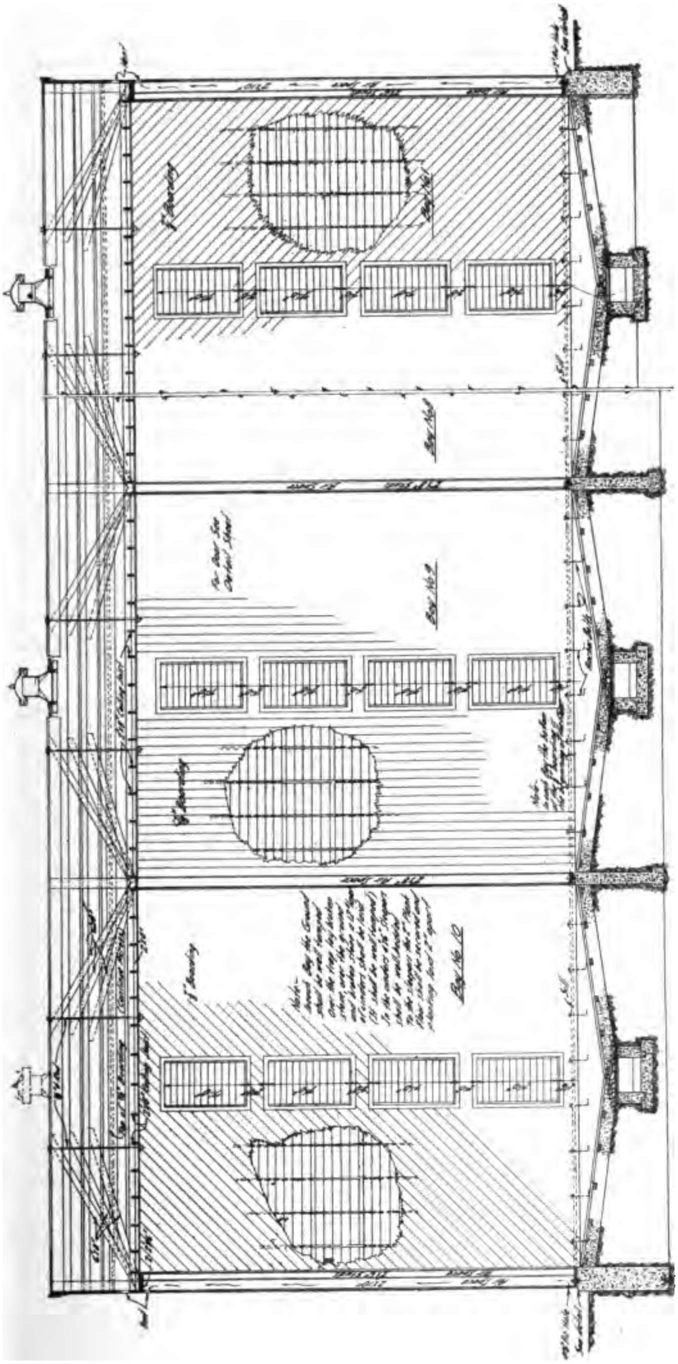


Standard Ice Storage House, D. & R. G. R. R.



ELEVATION TOWARD HOUSE   TRACK ELEVATION   SECTIONS THRU ELEVATOR CARRIAGE AND LOADING PLATFORM

Ice Elevator Carriage, D. & R. G. R. R.



LONGITUDINAL PART SECTION OF ERIE RAILROAD CO. ICE HOUSE AT MARION, OHIO

Denver & Rio Grande R. R.

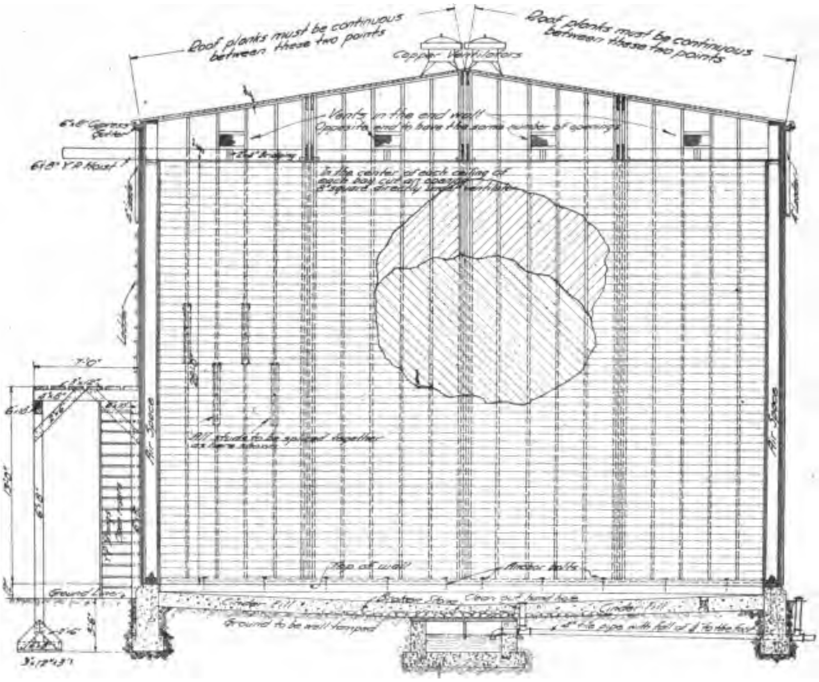
This company has a standard house of wood frame construction built in compartments, more being added when increased storage capacity is required. The novel feature is a traveling framework carrying a vertical belt conveyor which handles the ice to or from any door when the elevator belt is placed in front of the door.

The general features are described in the following letter from assistant chief engineer, Mr. Arthur Ridgway:—

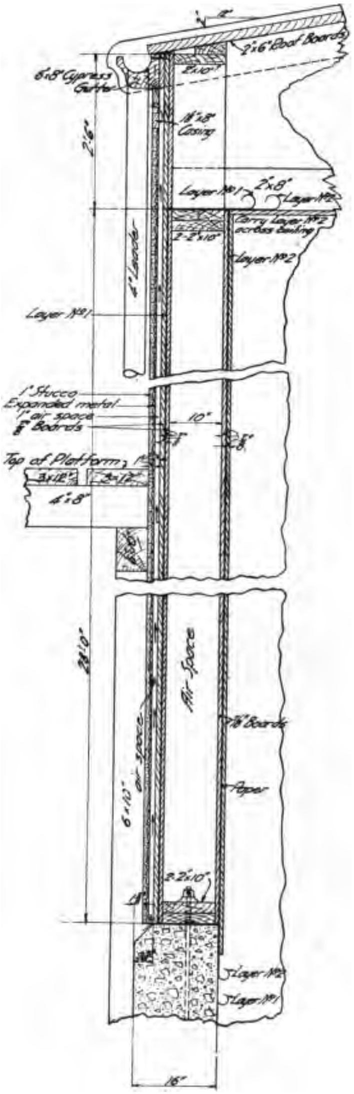
Before definitely and finally adopting conclusions in the matter of ice houses, I am wondering if we could not interest you, at least to a slight extent, in our scheme of constructing ice houses and method of storing the ice in the houses and icing cars during the refrigerating season. With this in view, I am attaching hereto photographically reduced plans showing general plans of the houses and icing elevator. You will observe that the houses are designed for the addition of units from time to time, and that the movable elevator serves the dual purpose of storing ice in the houses in winter and removal of the ice from the houses to the icing platforms during the refrigerating season. To be sure, we are from time to time revising these plans in minor details to suit changing conditions, but on the whole these small sheets will show the general scheme.

Erie Railroad.

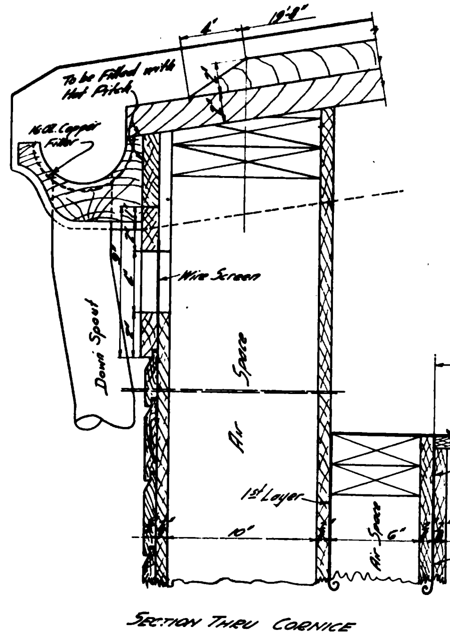
The ice houses on the Erie R. R. were described by Mr. F. A. Howard, engineer of bridges and buildings. The Erie has no brick or concrete houses. Mr. Howard's letter follows:—



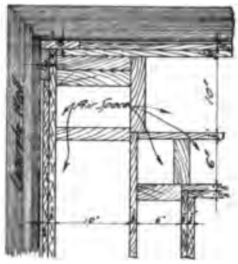
CROSS SECTION
ERIE RAILROAD CO ICE HOUSE
PORT JERVIS N.Y.



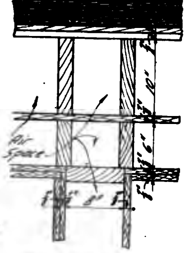
VERTICAL SECTION THRU EXTERIOR WALL
ERIE RAILROAD CO ICE HOUSE
PORT JERVIS N.Y.



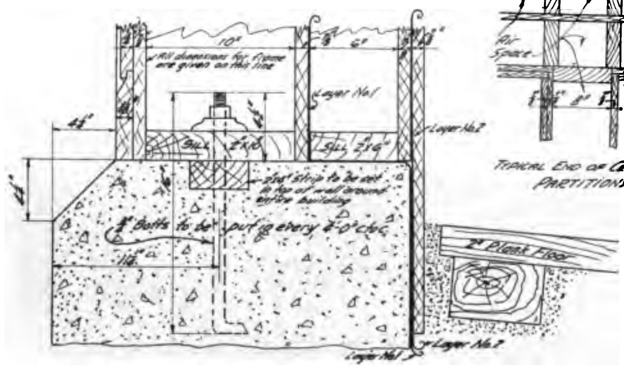
SECTION THRU CORNICE



TYPICAL CORNER OF BUILDING



TYPICAL END OF CENTER PARTITIONS



SECTION-TOP OF FOUNDATION WALL
ERIE RAILROAD CO. ICE HOUSE
MARION, OHIO.

Our ice house at Marion, Ohio, cost complete, $38,260. This gives a cost per cubic foot of $.0537 and $1.859 per square foot of ground area, measured outside to outside. The capacity in tons, of this ice house, when filled to the ceiling, is 19,565 tons. The cost of the house, per ton capacity, is $1.955.

The extension of the Port Jervis ice house cost $6,757, or $.0571 per cubic foot, and $1.51 per square foot of ground area, measured from outside to outside. The rated capacity of this house is 3,200 tons, making the cost per ton of rated capacity, $2.111.

Great Northern Ry.

The practice of the Great Northern was described as follows by Mr. A. H. Hogeland, chief engineer, the information referring exclusively to wood frame construction as that company has no brick or concrete houses:—

The size and capacity of rooms is 32x32 ft. in plan, holding about 400 tons, and 24x30 ft. holding about 250 tons. The foundations under the walls are of footing stones. No floors are provided. The wall and partition construction for the frame house consists of siding studs, 13-16 in. boarding, one thickness of Giant paper strips and 13-16 in. boarding.

The insulation of the ceiling is sawdust with no roof insulation. The doors are of refrigerator construction. The platforms are plain. No platform conveyors are installed. The elevators and skids for filling are furnished by the filling contractors.

We do not store artificial ice. Natural ice is stored on a flat side, the cakes being 20x22 in. in size. No space is left between cakes while the cavities between the ice and the walls vary. Insulation of ice is secured by sawdust filling between the studs and above the ceiling. No strips of wood, paper, sawdust or cork are placed between layers of ice.

The percentage of shrinkage under various conditions is about 20 per cent.

We endeavor to give the icing foreman sufficient notice to enable him to get the ice on the platforms before trains arrive.

The cost of houses averages about $2 per ton.

Illinois Central R. R.

The practice of the Illinois Central R. R. was set forth by Mr. A. S. Baldwin, chief engineer, as follows, being descriptive of a 4,000 ton wood frame house at Centralia, Ill., built in 1912, this company having no concrete or brick houses:—

The outside dimensions of rooms are 45x145 ft. in plan. The capacity consists of 4 stalls holding 1,000 tons each, 44½x42 ft. in the clear and 31 ft. high to the top of the ice when the house is filled.

The foundations under the walls and partitions are of concrete. The foundation under the wooden floors consists of a concrete base with a cinder cushion. The plank floor is insulated by laying it 1 in. apart on 4x4 in. sleepers.

The wall is built of 2x10 in. studs, 18 in. between centers, with sheathing, 2 in. of cork and ½ in. of plaster on the inside, and sheathing, paper, ½ in. flaxlinum, 2 in. furring strips, paper and siding on the outside. The total thickness of the wall is 1 ft. 5½ in. The cross walls consist of 2x10 in. studs, 18 in. between centers, with sheathing, flaxlinum, ⅞ in. furring strips and 1 in. sheathing on both sides.

The ceiling consists of 1 in. loose boards laid on top of the ceiling joists with no insulation. The roof covering consists of prepared roofing on 2x10 in. rafters spaced 24 in. between centers, with flaxlinum and sheathing on the under side.

The attic space is 6½ ft. high with no insulation.

The capacity of the elevator is two 200-lb. cakes. It will elevate 8 to 10 tons per hour.

Natural ice is stored. The cakes are 22 in. square, ranging from 8 to 14 in. in thickness and are stored on ends as close together as possible, each tier being reversed and the top leveled off, making all tiers uniform. The last tier is stored flat. Irregular cakes and broken ice are used to fill in at doors and under runways. There is practically no space between the ice and the walls. The space between the ice and the ceiling is 6 ft. Ice is stored solid, tier after tier without anything between tiers. This method permits the storage of more ice and does away with shrinkage that results from having to wash ice that has been stored with sawdust, cork, etc., between tiers. The covering of the ice is of wheat straw to a thickness of two or three feet.

The method of handling ice when withdrawn during a short busy season is practically the same as when withdrawn during a long season. One tier is taken at a time and care is exercised that no large surface is exposed to the air. A large chisel bar is used in digging the ice.

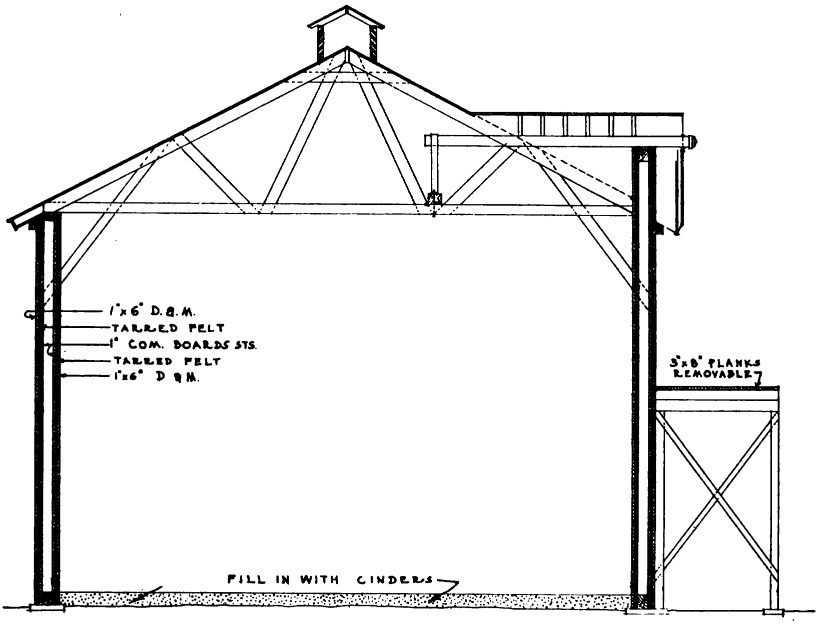
A 5 in. tile extends through the center of the house for the full length, to provide drainage. We concrete the main floor on which are laid 2x6 in. timbers on 4x4 in. timbers. The roof truss is of the Howe type, designed to carry a load of 120 lbs. per sq. ft.

While the percentage of shrinkage varies, the average should not exceed 8 per cent. Ice is gotten out ahead of trains and covered by tarpaulins while waiting the arrival of cars.

This house cost $15,200, or $3.80 per ton.

Minneapolis, St. Paul & Sault Sainte Marie Ry.

The practice of this road is set forth in the following letter from Mr. G. A. Manthey, assistant superintendent of bridges and buildings:—



SECTION
40'x 90' ICE HOUSE
CAPACITY 1700 TONS
M. ST. P. & S. STE. M. RY.

The sizes and capacities of rooms are 30x60 ft. in plan by 24 ft. high which holds about 850 tons, and 40x90 ft. by 24 ft. high holding about 1,700 tons.

The foundations of the walls and partitions are blocking and cinders. The floors consist of cinders. The insulation of the wall and partitions is secured by a 1 in. air space and 8 in. of sawdust. No ceiling is provided. The roofing consists of 1 in. dressed and matched lumber and Carey's roofing. The attic is open to the wooden rafters. The doors are built of two thicknesses of dressed and matched lumber with a 1 in. air space between, and a 6 in. air space between the outer and inner doors; the inner doors are of 2 in. movable plank.

The platforms are built of 8x8 in. posts and caps with 3x8 in. joists 16 in. on centers, and a 3x8 in. covering. The platforms are 8 ft. wide, and 13 ft. 6 in. high from top of rail.

The cakes of ice are 22x24 in. They are stored flat with no space between cakes. The cavity between the ice and the walls is 4 in., while the ice is packed to the collar beams. Sawdust is used as insulation on top, with no sawdust, paper or wooden strips between the layers of ice.

No drainage is provided.

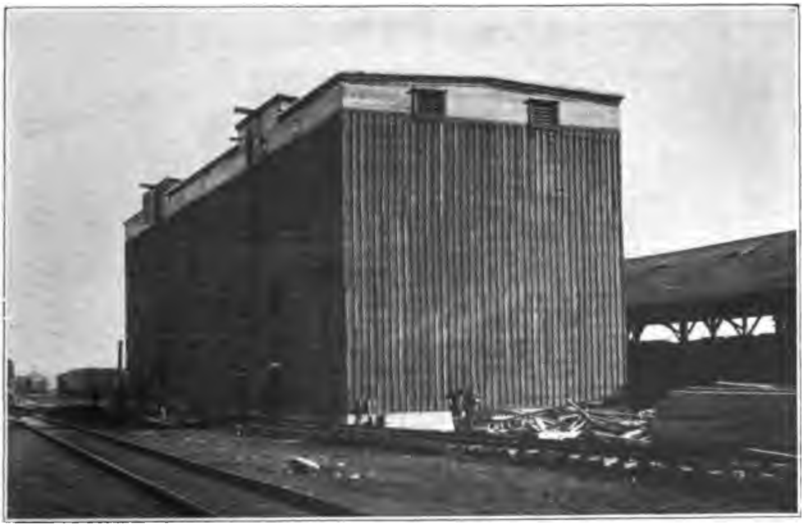
Howe trusses are used.

The percentage of shrinkage under various conditions averages about 5 per cent. Refrigerator cars are spotted along the platform. Ice is distributed along on the platform and skidded into the openings of the cars.

The cost of the larger size house (40x90-24 ft.) is $2,642, or about $1.56 per ton.

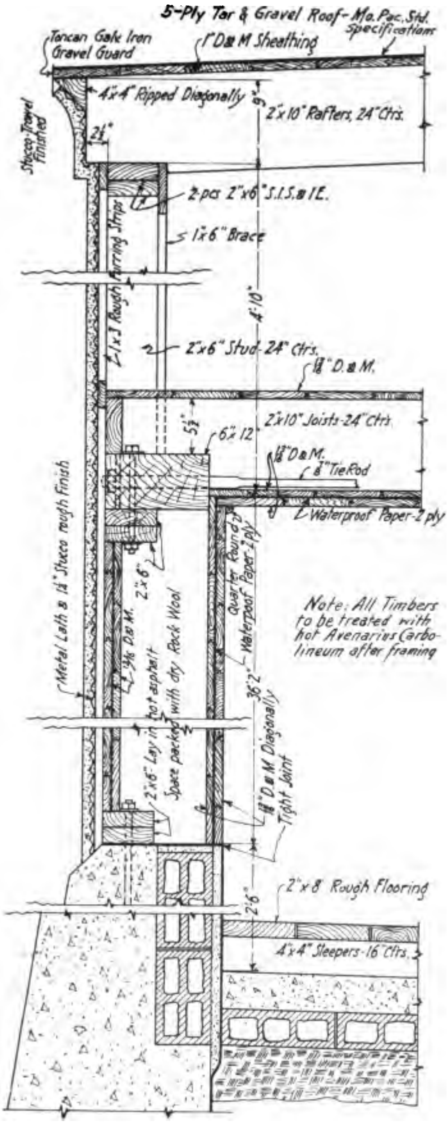
The cost of handling 8,812 tons of ice at Stevens Point, Wis., for the season of 1913 was $1,823, or $.207 per ton.

Our general plan of hoisting ice from the house is by a 6 h. p. portable gasoline engine mounted on a truck and moved from room to room on a platform in a very few minutes.



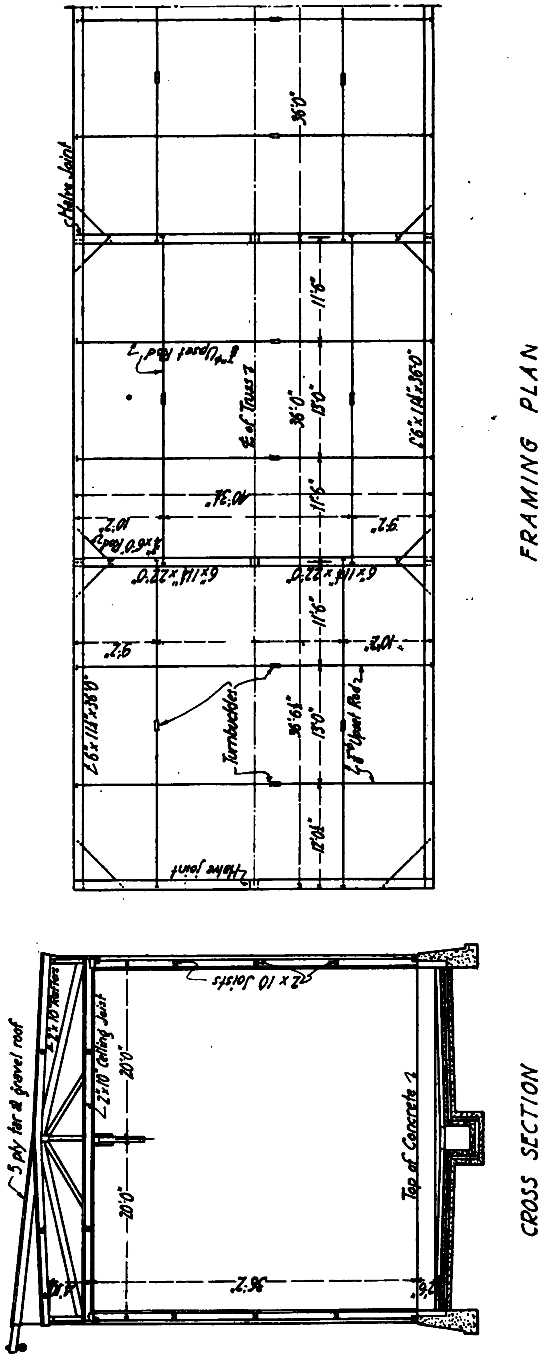
Ice House with 4,000 tons capacity, Mo. Pac. Ry., Hoisington, Kansas.

(Note: Cut shows vertical strips which are to be covered with metal lath and 1¼ inch of stucco, rough finished).

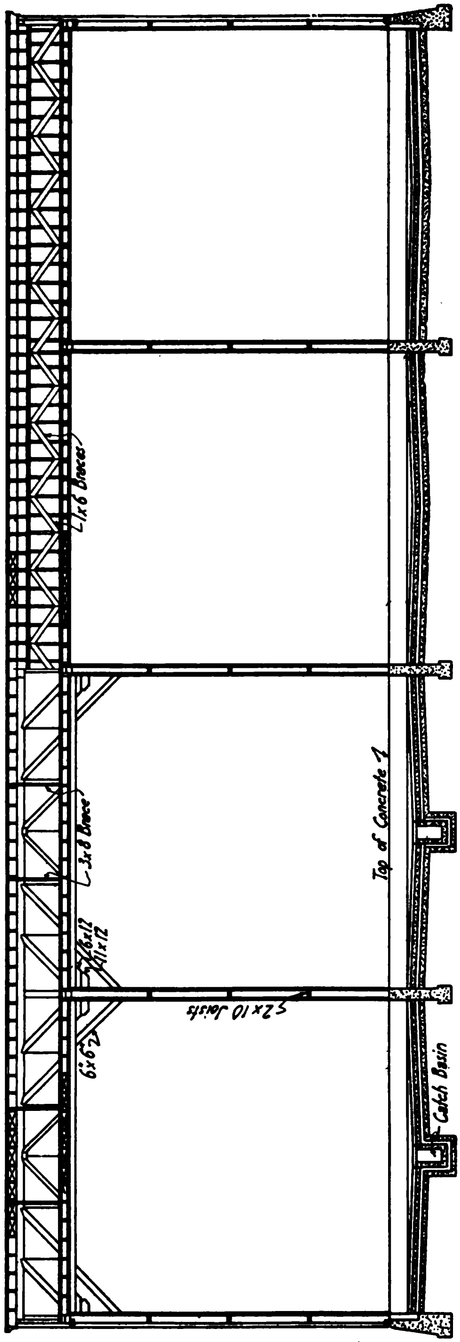


SECTION THRU OUTSIDE WALL

Section Through Outside Wall, Mo. Pac. Ice House at Hoisington, Kansas.

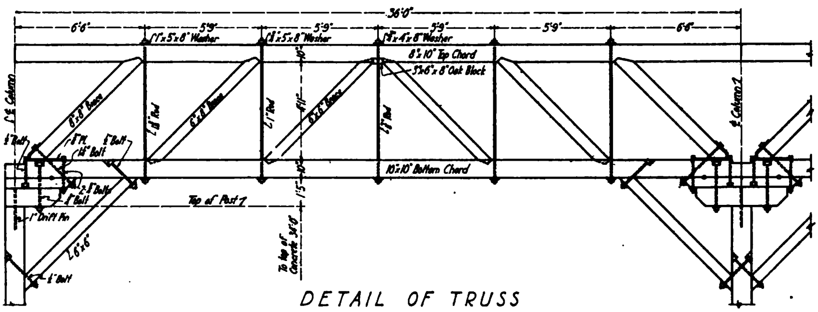


Cross Section, and Framing Plan for Mo. Pac. Ice House at Hoisington, Kans.



LONGITUDINAL SECTION

Longitudinal Section of Mo. Pac. Ice House at Hoisington, Kansas.



Detail of Truss for Roof of Mo. Pac. Ice House at Hoisington, Kansas.

The Missouri Pacific Ry.

This railroad has a number of wood frame ice houses and no brick or concrete ice houses. Its best practice is exemplified in the details of the 4,000 ton ice house constructed in the fall of 1913 at Hoisington, Kansas, after careful study of several types of construction, described by Mr. C. E. Smith, assistant chief engineer:

The house is divided into four rooms, each having a capacity of 1,000 tons, and each being 36 ft. long parallel to the track, 40 ft. deep and 38 ft. high. The foundations under the walls are of concrete 15 in. thick at the top, 12 in. above the top of rail, and resting on footings 2 ft. 6 in. wide, 6 ft. below the top of rail 3 to 4 ft. below the natural ground line. The inside of the wall is insulated from its top to 8 in. below the top of floor, a vertical height of 3 ft. 2 in. by 6 in. double wall hollow tiles set in the forms at the inside of the wall and plastered over on the inside. The partition foundations are 13 in. thick, level with the outer walls, and are not insulated.

Special care was taken in the design of the floor to secure good insulation. The ground was first leveled off and covered with 6 in. of engine cinders well tamped, sloping from the four sides of the room with a total drop of 5 in. towards the center. On top of the cinders was placed a layer of 4 in. hollow tiles on flat. They were covered with a 4 in. layer of concrete forming the top surface of the floor.

At the center of each room is a concrete catch basin 3 ft. square and 3 ft. deep insulated in the same manner as the floor. The outlet is a 4 in. cast iron pipe connected in such a way as to effectually trap the catch basin.

The outer walls are made up of the following, beginning at the inside:— 13-16 in. dressed and matched boards laid horizontally; 2-ply waterproof paper; 13-16 in. dressed and machined lumber laid diagonally; 3x1 in. studs, 36 ft. long, placed 2 ft. center to center; 13-16 in. dressed and matched boards laid diagonally; 2-ply waterproof paper; 13-16 in. dressed and matched lumber laid horizontally; and 1x3 in. strips placed vertically on 12 in. centers.

The latter strips were put on as lathing for expanded metal and stucco extension to be placed later for fire protection and for additional insulation.

The construction of the partitions was identical with that of the outer walls except for the vertical strips.

At 9 intervals vertically, horizontal girts were placed completely around the walls and partitions between the studs. The spaces between the studs and sheathing were filled with dry rock wool, rammed in.

Roof trusses 6 ft. 7 in. deep extended along the entire length of the house. The ceiling consists of 2x10 in. joists 2 ft. center to center, 18 ft. long resting on the side walls and on the bottom chords of the

trusses. The under sides of the joists forming the top of the storage rooms are sealed by 2 layers of 13-16 in. dressed and matched lumber with 2-ply waterproof paper between, connected to the wall sheathing to form a tight joint. The space between the joists was packed full of rock wool and the joists floored over with one layer of 13-16 in. dressed and matched lumber.

The roof was likewise supported by 2x10 in. joists placed 2 ft. center to center, making an attic 4 ft. 10 in. to 5 ft. 6 in. high in the clear. The joists were covered with a single layer of 1 in. dressed and matched sheathing on a 5-ply tar and gravel roofing. The vertical space surrounding the attic space over the walls was boarded in on the south side; two louvres were placed at the east and west ends and two slat doors at the tops of ladders at the north side, to afford ample ventilation.

No doors or other openings are provided in the partitions between the rooms nor on the east, west or south walls of the storage rooms. At the north side adjoining the track, two doors, each 3 ft. square are provided for each room, one door at the level of the platform for receiving ice from cars and the other at the level of the platform for icing cars. In addition there is a trap door in the ceiling of each room immediately over a ladder to give access from the attic. Each door is composed of two pieces, forming in effect a double door, inside and out, held together by threaded bolts and wing nuts. Each part of each door is 7 in. thick, having three layers of sheathing and filling of rock wool.

The platform is 15 ft. wide of ordinary light trestle construction. At present it is 240 ft. long but it is the intention to extend it later to 40 car lengths to accommodate an entire train. No platform conveyors are being provided. For the present wheelbarrows or buggies will be used, but later on a continuous link conveyor will be installed on the long platform.

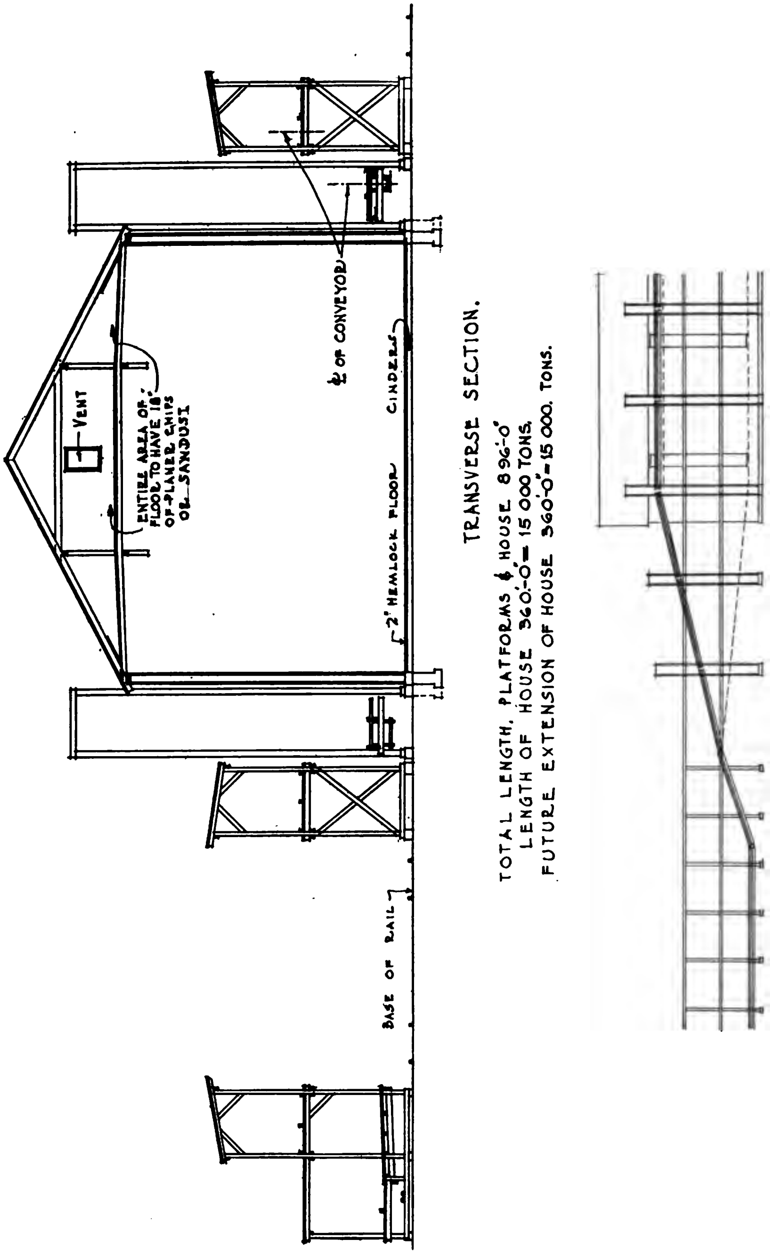
Elevators will be used for filling and emptying the house. An elevator shaft 5x6 ft. was constructed in each room just inside the doors. A skip or carriage 3 ft. wide and 5 ft. long operates inside each of these shafts operated by a cable extending to an electric motor located in the attic. The four skips are connected to the same hoist and any two can be operated simultaneously from the platform. The floor of the skip can be adjusted to slope into the house to more readily receive and discharge ice when filling the house and to slope out when emptying. The capacity of each skip is three trips per minute, with 1,600 lbs. to the trip, or 4,800 lbs. per minute, equal to 125 tons per hour. Thus the skips will handle the ice faster than it can be brought in or taken away.

The ice is stored on flat in gentle contact and close to the walls and ceiling. The experiment has been tried of separating the layers with waterproof paper to prevent the circulation of air but it is too early yet to give results. No sawdust, cork, hay or other similar insulation was used.

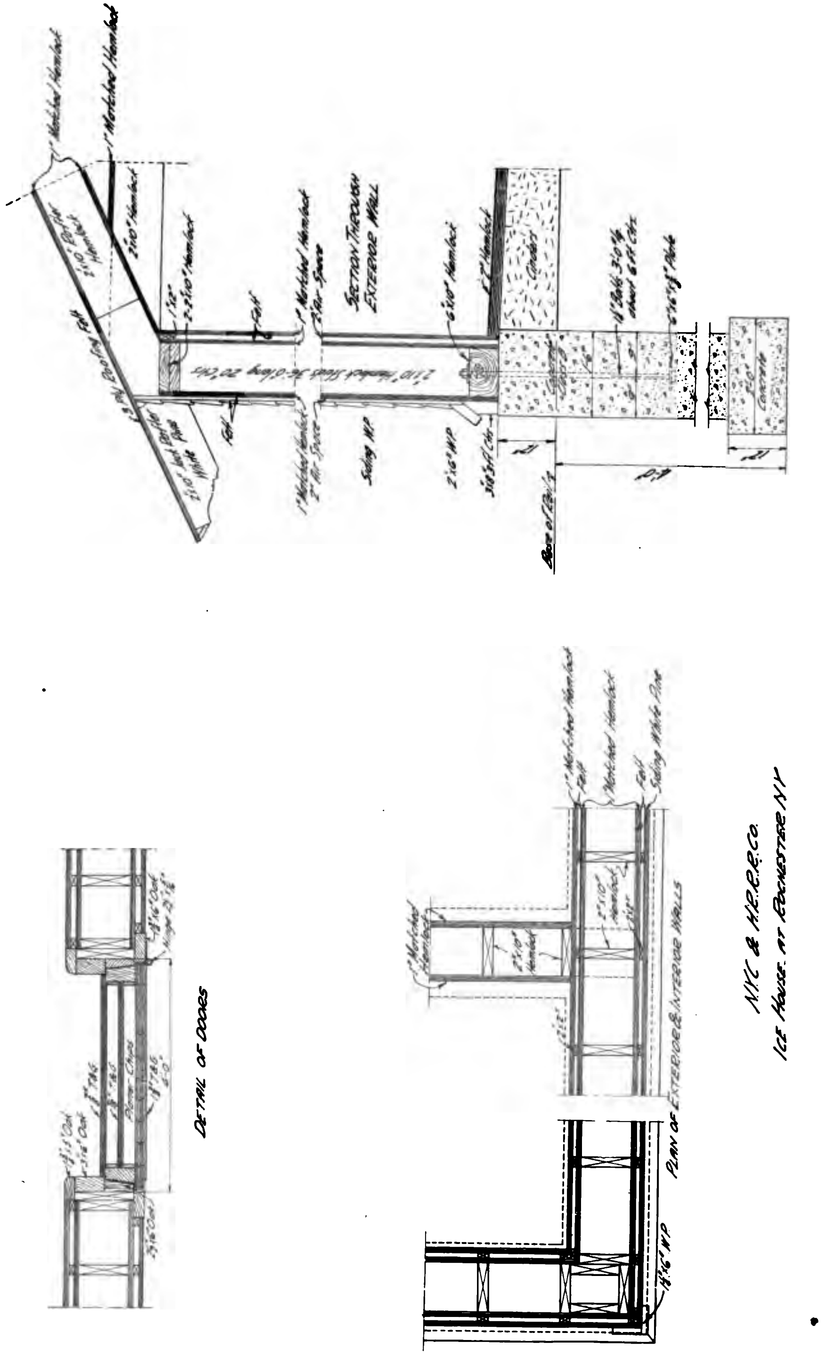
This house will supply a small amount of ice during the entire year but will be emptied rapidly in August, September and October when the fruit moves. On account of the short platform it will be necessary to get the ice out while the cars are being moved by. When the entire platform is built the ice will be distributed by a conveyor just ahead of trains.

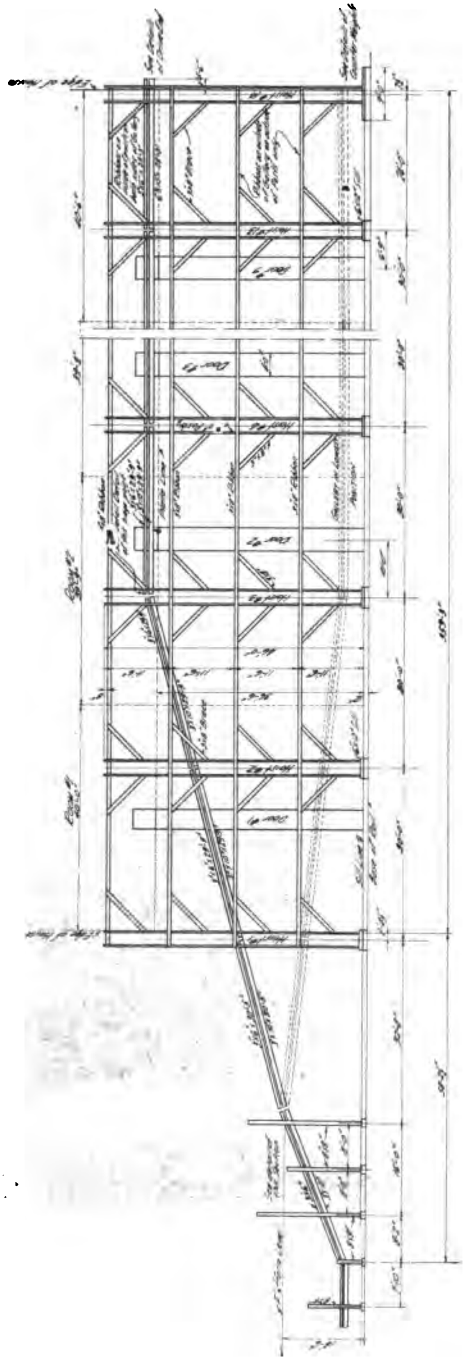
This house cost about $12,000, or about $3 per ton of ice stored. A shrinkage of only 5 to 10 per cent is expected. It is not intended to install refrigerating pipes to cool the rooms. In order to prolong the life of the house all the wood work was brush-coated or dipped in the field, with hot wood preservative.

The illustration shows the house before the construction of the platform. It was constructed in record time, having been made ready for ice in six weeks after receiving authority to go ahead with the work.

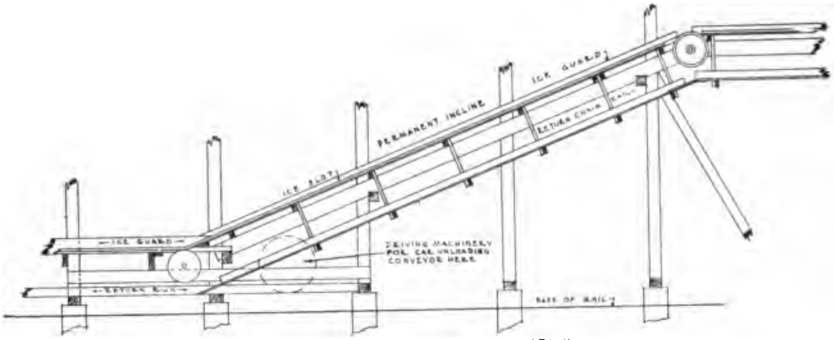


N. Y. C. & H. R. R. Ice House at Rochester, N. Y.


SECTION THROUGH EXTERIOR WALL
DETAIL OF DOORS
PLAN OF EXTERIOR & INTERIOR WALLS
N.Y.C. & H.R.R.R.CO.
ICE HOUSE AT ROCHESTER N.Y.

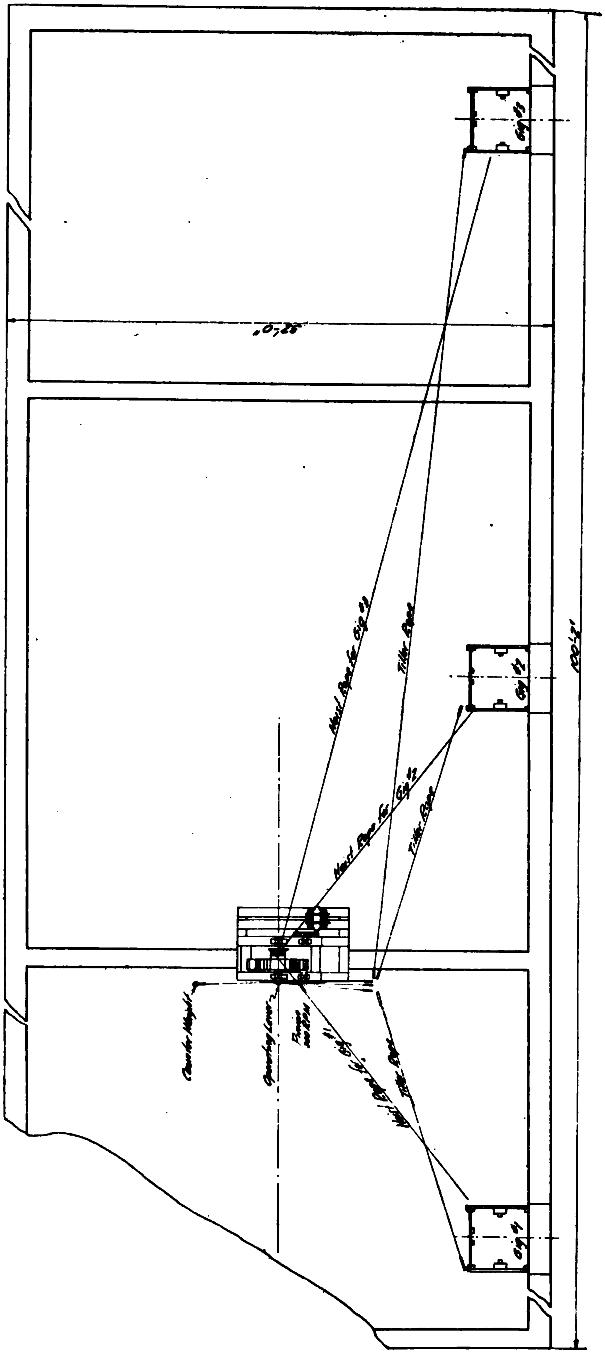


Car Unloading Platform and Gallery Conveyor for N. Y. C. & H. R. R. Ice House at Rochester, N. Y.

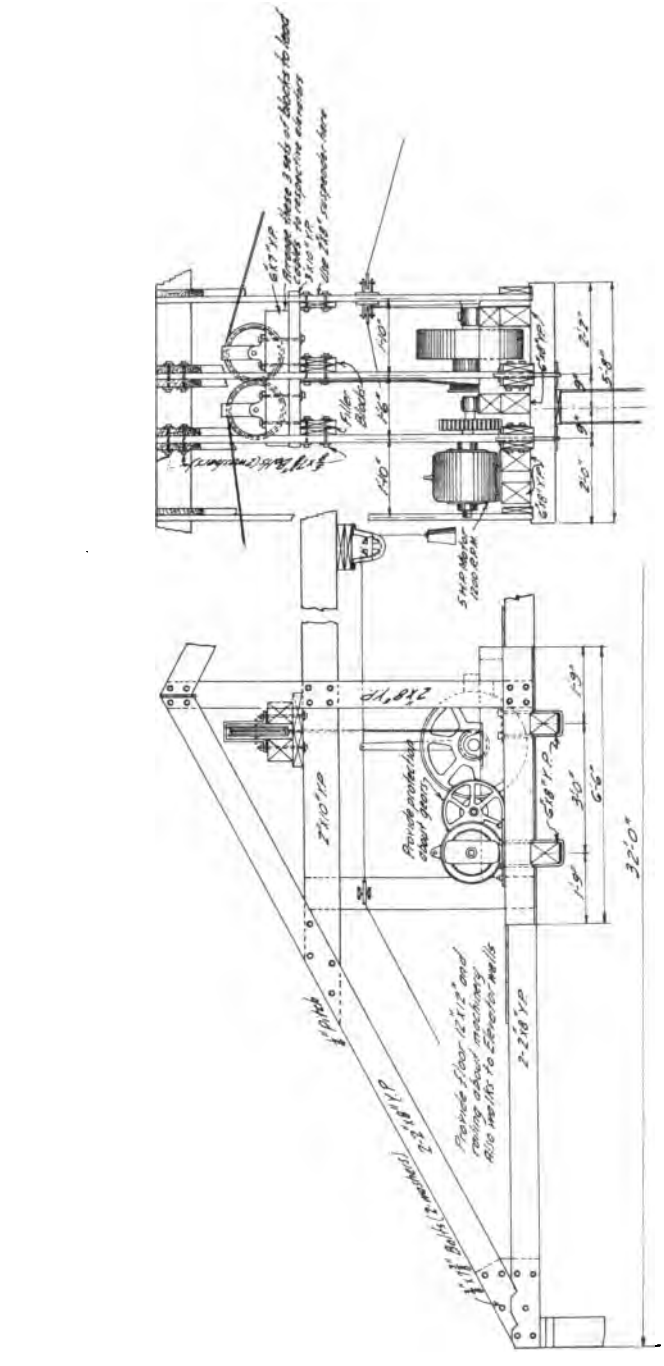


SECTIONAL SIDE ELEVATION
ICE HOUSE AT
ROCHESTER
N. Y. C. AND H. R. R. R.
ROCHESTER DIV.

Union Pacific Ice House, Grand Island, Neb.

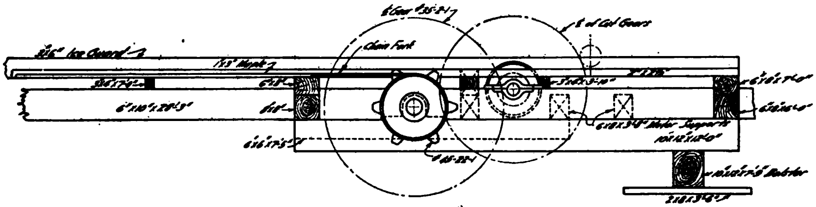


GENERAL ARRANGEMENT FOR HOIST AND TILLER ROPES
FOR ICE HOUSE-N.Y.C.&H.R.R.R.CO.-ST. LAWRENCE DIVISION

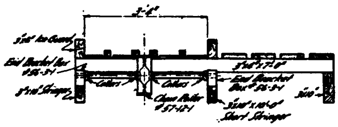


SPECIAL TRUSSES AND MACHINERY BED

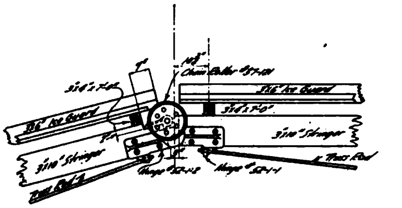
Arrangement of Machinery in Roof Trusses of N. Y. C. & H. R. R. Ice House.



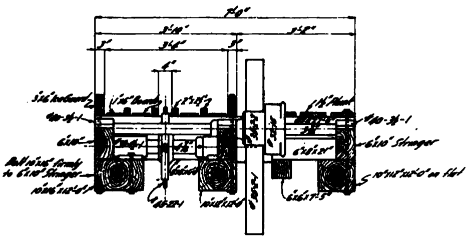
Sectional Elevation of Driving End



End Elevation of Gallery Showing Chain Roller



Detail of Chain Roller and Hinge at Hoist #3



Cross Section of Driving End

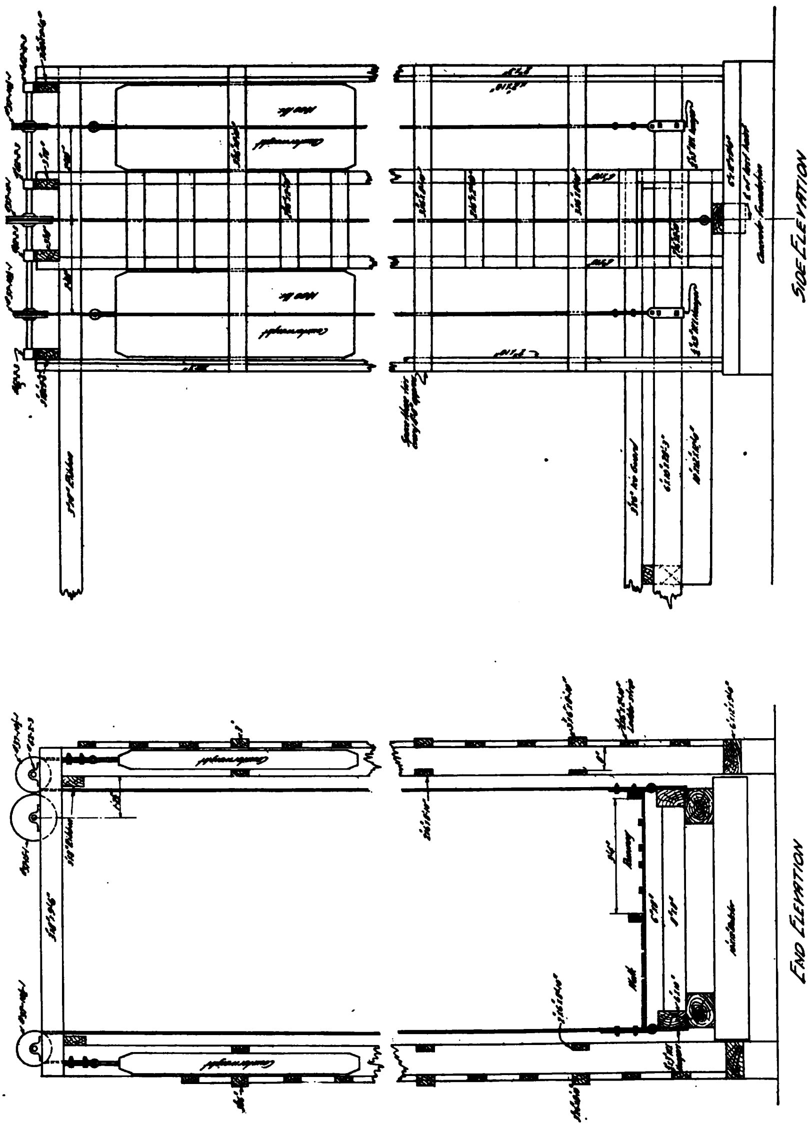
Details of Elevator Conveyor for N. Y. C. & H. R. R. Ice House.

New York Central and Hudson River R. R.

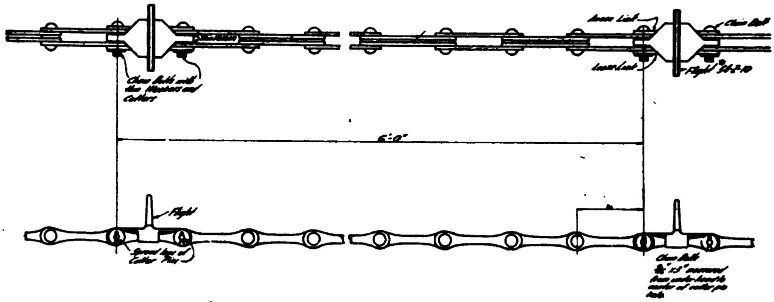
The committee was particularly pleased with the full information and prints furnished by the N. Y. C. & H. R. R. R. Co., and deems the information of such great value as to reprint it here in full. Mr. W. A. Pettis, general superintendent of buildings, a member of the committee, went into the subject very thoroughly with Mr. G. W. Vaughan, engineer maintenance of way. The information is of particular interest as it refers to 73 ice houses having a combined storage capacity of 240,000 tons. It is interesting to note that all the ice houses of this company are of wood frame construction, there being none of brick or concrete.

The report of Messrs. Pettis and Vaughan is as follows:—

On the lines east of Buffalo, except the Boston & Albany, we have 73 ice houses with a total capacity of 240,000 tons. Fifteen houses are equipped with platforms and ice handling devices and the other 58 are small ordinary storage houses for ice for use in local territory. We will describe two recently built types of houses, viz., large icing stations with up-to-date mechanical equipment, and smaller houses for side line traffic.



Details of Hoist and Counterweight Wells for N. Y. C. & H. R. R. Ice House at Rochester, N. Y.



ASSEMBLY OF CHAIN AND FLIGHT
AS USED ON ELEVATOR CONVEYORS
ONLY N.Y.C. & H.R.R.R.Co. ROCHESTER
AND OSWEGO N.Y.

Large Houses.

Our three best equipped houses are fairly uniform in construction, but vary in size. As typical of this type, refer to the Rochester house. These houses are 60 ft. wide by 120 to 240 ft. long. We locate the houses so that additional rooms can be added in the future. The inside dimensions of rooms are 38 ft. 9 in. x 57 ft. 6 in. by 36 ft. high, with a capacity of 1,700 tons each. The size and capacity of the rooms should be adjusted to local conditions. Doorways should be spaced 40 ft. center to center, that being the approximate length of cars. The larger the body of ice the better it will keep.

The foundations under the walls are of concrete, and that or stone should be used in all cases. Ice melts very quickly if air gets through the foundations. The foundation under the floor consists of 12 in. of cinder filling, well tamped. The foundations under the partitions are of concrete. While not absolutely necessary for the proper keeping of ice, concrete or stone makes a better and more permanent structure.

The floors are of 2 in. plank spiked to sleepers, for which old 8x10 in. bridge ties, old car sills or other timbers may be used. We have never used any insulation other than the foundation of cinders, and we do not think it essential if proper foundation walls are used.

Beginning at the outside the walls and partitions are,—siding, sheathing paper, 2 in. live air space, sheathing paper, 1 in. hemlock, 10 in. air space, 1 in. hemlock, sheathing paper, 2 in. air space, sheathing paper and 1 in. hemlock. Our standard construction up to 1913 called for sawdust or shavings to be used in the exterior walls of houses, but during the last 2 or 3 years we have not used anything between studding in the 10 in. space. The 2 in. outside air space has an opening back of the water table and extends the entire height to about 8 ft. up the rafters and opens into the attic. Interior partitions are of 1 in. sheathing each side of the studding, giving a 10 in. air space. No paper is used.

The ceiling is entirely floored over and 18 to 24 in. of shavings are placed on the top. Experience seems to question the advisability of this plan for several reasons:— 1st. Floor joists and flooring rot out in about 6 years, and renewals are very expensive. 2nd. Much space is lost because workmen can not pack ice within 3 ft. of the ceiling, thus necessitating a house 3 ft. higher than would otherwise be the case for a given tonnage. 3rd. Ice would really keep better if the ceiling were omitted and the roof insulated instead, and the ice covered with 12 in. of swamp hay. Under this plan it is believed the shrinkage would be much less.

The attic and roof are well aired by large ventilators set on the ridge of the roof, and a door at each end of the house. The gable roof is ceiled on the under side of the rafters to a point where the distance

from the attic floor to the roof is 2 ft. In case the ceiling of the houses is omitted, the under side of the rafters should be entirely ceiled and the space filled with shavings. A ventilator should be placed over each bay.

Doors are 9 in. thick with a clear width of 3 ft. 6 in., containing one air space and one space filled with shavings.

A platform is suspended against one or both sides of the house carrying an endless chain conveyor, which is lowered or raised according to the height of the ice in the rooms being worked. The long platform 14 ft. 6 in. above the base of rail is for icing cars, and the short platform below is for filling the house.

The Gifford-Wood conveyors are used. The motive power is electricity. The conveyor on a suspended gallery is reversible to fill or empty the house. Where the conveyor of the suspended gallery joins the icing platform men are stationed to push the cakes to conveyors running each way along the platform from that point.

From 5 cakes per minute for the oldest house of this type to 12 cakes for the newest, can be handled. From 25 to 30 cars per day can be stowed with a force of 45 men. The ice averages 25 to 28 tons per car. All ice comes by railroad and is packed as closely as possible. The standard size of cakes is 22 x 32 in. by 12 to 24 in. thick. We prefer them 12 in., as handling 24 in. ice costs more in the end. We believe ice comes out better and with less breakage when stored on edge, but it can be more easily and quickly packed when laid flat. Our practice in this respect is not uniform. We place the cakes in contact as solidly as possible. No space between the ice and the wall is necessary with houses of this design.

The space between the ice and the ceiling is 3 to 4 ft., because it is impossible to work in less space. The ceiling may well be omitted to avoid this. No insulation for the ice is provided. We use no wood between layers for natural ice, but this is necessary for artificial ice to prevent freezing together.

No sawdust is placed between layers. At railroad houses ice is not well cleaned when removed and the sawdust makes a bad mess. In refrigerator cars it causes trouble by clogging the drip pipes. Cork is too expensive, in addition to its being a nuisance like sawdust. If the construction of the house requires a covering, swamp hay is the best material as it can be used several times. The top layer of ice is always covered and it is not as dirty as sawdust and shavings. There is no difference in methods of handling for a short busy season and a long slow one for conditions which vary from a few cars per day in the spring and summer to 200 cars per day in the fruit season.

The sub-grade and floor of each room is sloped ½ in. per ft. to the center. A 6 in. tile drain is provided for each room extending from the catch basin at the bottom of the cinders. In a good percolating soil, however, a drain is not necessary. There must be a trap in the drain to prevent the entrance of air.

For houses kept closed the shrinkage will average 15 per cent; with doors open more or less of the time this will amount to 25 per cent; doors open most of the time will result in a loss of 50 per cent or more. With doors carefully supervised and good swamp hay covering, shrinkage should not exceed 10 or 15 per cent. Ice is drawn before or after arrival of trains depending on operating conditions. In busy times conveyors are constantly at work.

The cost of the house 240 ft. long, with a capacity of 10,000 tons including platforms and machinery (but not the tracks) at Rochester, built in 1913, with six rooms, was $60,000 or $6 per ton. The house at Oswego, built in 1913, with three rooms, 120 ft. long and a capacity of 5,000 tons, was $25,177, or $5.05 per ton. The former has very long platforms with a total length of 1,800 ft., extending beyond the end of the house on each side. The latter house has shorter platforms with a total length of 1,500 ft. on one side only, thus having only half the

outfit of motor and hoisting machinery, and a little more than one-fourth of the conveyor chain.

Moderate Size Houses.

To describe other recently built houses of small capacity and not so elaborate equipment, I refer to houses at North Rose and Model City. The size of rooms is 48x28 ft. and 24 ft. high, with a capacity of 735 tons. Some houses are 33x32 ft. and are same height with a capacity of 500 tons.

The foundations are posts, or they may be old bridge ties, but concrete is sometimes used and is preferable. The floors are of 2 in. hemlock plank on 18 in. of cinders. Plank should be spiked to the sleepers for which old bridge stringers or old car sills may be used.

The walls are similar to those in larger houses, viz., beginning at the outside: siding, sheathing paper, a 2 in. air space, sheathing paper, 1 in. hemlock, an 8 in. air space, 1 in. hemlock, sheathing paper, a 2 in. air space, sheathing paper and 1 in. hemlock. In some cases the larger air space is empty and in others it is filled with shavings. The outside 2 in. air space is ventilated. The partitions consist of studding sheathed with 1 in. hemlock, leaving a 10 in. space which is filled with shavings or sawdust if desired. The ceiling is built with rafters ceiled on the under side, or ceiling joists ceiled on top. In some cases the latter is covered with 14 in. of shavings or sawdust, and in other cases not. In the Pennsylvania division houses no ceiling was placed but the roof was insulated by 1-ply tar paper and ceiling on the under side of the rafters, while the space to the top of rafters was filled with shavings and then tongued and grooved roof sheeting, finished with some type of prepared felt roofing. The space under the roof in all houses is well ventilated, in the cheaper houses by louvres in each end, and in the better houses by 6x8 ft. ventilators along the roof, and doors or louvres in each end of the house.

The doors are the same as previously described for the larger houses.

On the latest houses the platforms are 6 ft. wide and are supported by brackets on the side of the house. On the Pennsylvania division houses the platforms are 4 ft. 8 in. wide and are supported by piers. No conveyors are used on the smaller houses. Elevators operated by steam or electricity are used. The gig used on the St. Lawrence division will handle four cakes per minute; most of our installations will handle about two cakes per minute. Natural ice exclusively is handled and stored. The standard size of cakes is 22x32 in. by 10 to 24 in. thick. No standard is adopted, but ice is stored flat in most houses and as compact as possible. A cavity of 6 or 8 in. is left between the ice and the wall while the space between the ice and the ceiling is two to three feet. A heavy covering of sawdust is placed on top of the ice and sometimes between the ice and the wall. Swamp hay is preferable to sawdust. Nothing of any kind is used between layers.

No standard method is adopted in removing the ice. In some cases it is lowered in all rooms uniformly and in others one room is emptied before working another.

In some cases seepage is found to be entirely sufficient to provide drainage. In others, blind drains or tile drains are provided, but are arranged so air currents can not enter the house. In some cases the floor is placed a little higher than the adjacent ground. The sub-grade of the floor should be sloped ½ in. in 1 ft., to carry the water to the center.

The shrinkage is estimated at about 10 to 12 per cent. At some houses where cars are iced daily with ice brought to the platforms some time in advance, the loss may reach as high as 40 per cent. Ice is gotten out ahead of trains or while they wait. At some houses ice for refrigerator cars is gotten out after they are spotted, and for milk cars before their arrival.

Two houses built in 1910 and 1912 for North Rose and Model City cost as follows:—

2,200 tons capacity, total cost, \$5,538, or \$2.51 per ton.
2,200 tons capacity, total cost, \$4,730, or \$2.14 per ton.

Two other houses built in 1912 and 1913 on the St. Lawrence division cost:—

1,500 tons capacity, total cost, \$5,742, or \$3.83 per ton.
1,500 tons capacity, total cost, \$5,092, or \$3.39 per ton.

Other less elaborate houses built from 1903 to 1911, according to the plan for the house at Newberry Jct., cost an average of approximately \$2.75 per ton, as follows:

500 ton	\$1,440
500 "	1,266
800 "	1,455
800 "	2,042
500 "	1,280
2,000 "	5,843
800 "	2,742
1,000 "	3,275

To the foregoing joint report Mr. Pettis added the following general conclusions:—

We have several up-to-date, fine looking ice houses. I sometimes think it a waste of money to follow our late standard as the construction is very expensive. I have often noticed the large ice houses on the Hudson river, many of which hold as much as 50,000 tons. The construction of many of these is very simple, with 2x12 in. studding, sheathed on the inside only, while a few are sided up on the outside.

In northern New York the large milk concerns build houses that hold from 10,000 to 12,000 tons. The construction is as follows: 2x12 in. studding on 24 in. centers, sheathed on each side with hemlock boards, no paper being used; the space is filled with sawdust; swamp hay 15 in. deep is placed on top of the ice while the space on the sides between the ice and the wall (about 6 in.) is filled with swamp hay. There are good sized louvres on the roof. Ice keeps well in these houses while the cost is hardly one-half that of our standard houses.

Ice houses should be painted white. Metal roofs should never be used. I would recommend a white roof of fine gravel covered felt, asbestos felt with the white side up or asbestos shingles. Wooden shingles should never be used on account of fire risk. Broken ice should be removed with the full cakes.

For a sensible and fairly cheap house I would recommend one constructed of concrete foundation walls with 2x10 in. studding, the interior and exterior being sheathed horizontally, with sheathing not over 6 in. wide. Place good saturated building paper over the entire exterior. Over each stud place 2x2 in. furring strips with paper on the strips and then cover with drop siding or novelty siding. This 2 in. air chamber should be open at the top and bottom, thereby forming a live circulating air space. The space between the studs to be filled with planer shavings if desired. The under side of rafters should be ceiled with 1⅛ in. narrow ceiling strips well nailed and the space between the roof boards and the ceiling packed with planer shavings. This keeps heat from penetrating the roof. Louvres should be provided on the roof not over 40 ft. apart with the openings covered with wire netting. Ventilating doors should be placed in each end and the openings covered with netting to keep out birds and sparks. I firmly believe that a house built in this way will keep ice in first class condition and it would be much less expensive than some of our modern houses.

Northern Pacific Ry.

The general practice of the Northern Pacific in frame ice house construction is clearly set forth by its chief engineer, Mr. W. L. Darling:—

The foundations under the walls and partitions consist of wooden blocking. The foundations under the floors are of natural ground with 12 in. of cinders. The ground is graded to the level of the top of ties and a layer of cinders 12 in. thick is placed on the ground and rolled. No other insulation is used.

At present no insulating material is used except sawdust between the walls and ice. In the proposed plan no insulating material will be in contact with the ice. The present practice provides for a sawdust layer on top of the ice only. It is proposed to place 2 ft. of sawdust on the suspended ceiling. The present practice provides for single thickness board doors, while the proposed practice will include doors of the refrigerator type.

From 20 to 25 tons of ice can be handled from the storage to the platform per hour. Natural ice is protected by sawdust, excepting in insulated houses where it is not covered. In insulated houses no protection is used generally. Very little artificial ice is handled but that is protected in the same manner.

Packing is done by contract. Two sizes of cakes are used,—22x22 in. and 22x32 in. They are stored flat. The cakes are packed with as small a space as possible. In insulated houses the ice is stored snug against the wall. In non-insulated houses it is stored one foot away. The ice is stored as near the ceiling as a man can conveniently work, usually about three feet.

In insulated houses no further insulating is done, excepting that in some semi-insulated houses the ice is covered with two thicknesses of building paper and about 1 ft. of hay or flax straw. In non-insulated houses, ice is covered with 1 ft. of sawdust, with the same amount between the ice and the walls. No strips of wood, paper, sawdust or cork are placed between layers.

The best method of handling ice when it is all withdrawn from the house during a short, busy period is by an endless chain conveyor from the house to the platform, or elevators of ample capacity. Ample platform room is needed and a conveyor with long platforms. The best method of handling ice when withdrawn uniformly through a long season, where storage in smaller rooms is desirable, is by means of ordinary gig elevators. Platforms may also be more limited in size.

In this climate no drainage is necessary for the melting ice. Drainage for surface water and water from the roofs depends on local conditions.

The general practice is to distribute ice ahead of trains, excepting in some few locations where it is practicable to have a large enough crew employed at other work so that the ice can be put out by one part of the crew as fast as cars can be iced by the remainder.

The cost of a house varies with the capacity from $1 per ton storage for the smaller houses of 750 tons, to 85 cents per ton capacity for the larger houses of 3,000 tons. The proposed houses will cost about $1.30 per ton storage.

(The small cost of houses, per ton of ice stored, on the N. P. Ry., as compared with other roads, is probably owing to the low cost of lumber on that road.—Ed.)

The Northern Pacific recently constructed a 30,000 ton reinforced concrete ice house at Pasco, Washington, and on account of the novelty of the design and the small amount of information available about concrete ice houses (on account of their infrequent construction) an article in the Railway Age Gazette of January 23rd, 1914, by Mr. Henry I. Church, assistant engineer and chief draftsman with C. A. P. Turner, consulting engineer, descriptive of that house is reprinted here:—

The refrigerator cars used by the Northern Pacific to transport the fruit raised in the Yakima Valley and the Walla Walla district are iced at Pasco, Wash. Two years ago this company suffered severely when almost their entire supply of ice was lost through the burning of a large wooden ice house at Pasco. When the railroad decided to rebuild, the question of fireproof construction came up; and even though investigation proved that reinforced concrete was about 25 per cent more expensive than wood, it was decided to construct the new building of this material.

The new ice house is 483 ft. long, 94 ft. 6 in. wide, and 41 ft. 10 in. high to the roof at the center line of the side walls, and has a storage capacity of 30,000 tons of ice. It is divided into 12 compartments by walls of the same construction as the exterior walls. These walls consist of two 4-in. concrete walls reinforced vertically and horizontally, and cast with a 10-in. space between them, which is filled with fine regranulated cork for insulation.

The walls are made rigid by building columns spaced from 9 ft. to 13 ft. 4 in., cast monolithic with the walls. Insulation around the exterior columns is provided by building U-shaped concrete pilasters and filling the space formed by the U with granulated cork. These pilasters were cast monolithic with the outside walls. The walls are given additional stiffness between columns and made to act together by inserting two 2 in. x 10 in. fir planks spaced equi-distant and extending the full height of the wall. Bolts, spaced 4 ft. apart and running through both walls on the same vertical line as the 2 in. x 10 in. timbers hold the two walls solidly together and give considerable additional stiffness to the structure as a whole. These bolts are long enough to hold in place the lagging on the inside of the building, which will be described later.

The floor is made of a 4 in. concrete slab reinforced in both directions, and laid on 16 in. of cinders well tamped for insulation. To provide drainage and give the ice a tendency to tip away from the walls, the floor is sloped from all four sides to the center in each compartment.

The ceiling is of the beam and slab type of reinforced concrete. The slab is 4 in. thick, reinforced two ways. The beams running lengthwise of the building are framed around the bottom chords of the trusses which support the roof and ceiling. The beams framing into the longitudinal beams are spaced so as to give panels 13 ft. 4 in. x 10 ft. 2 in. On top of the ceiling slab 2 in. x 6 in. timbers are placed 3 ft. between centers, and fine regranulated cork is tamped between them giving a 6 in. thickness of insulation. Boards 7/8 in. thick are nailed to the 2 in. x 6 in. timbers and covered with two layers of oiled paper. On top of this is placed 1½ in. of cement mortar reinforced with McMillan's wire netting. This construction gives a solid ceiling and provides excellent insulation.

The reinforced concrete roof is supported on 40 ft. Warren steel trusses with sub-verticals supported on the end and transverse walls. The roof slab is divided into panels of the same size as the ceiling and is covered with a tar and gravel roof laid under the Northern Pacific specifications. The slope of the roof is about 4 in. in 10 ft. This double construction of ceiling and roof is designed to give additional insulation and to provide room for ice chutes leading from elevators to the outside of the building. Ventilation of the space between the ceiling and the roof is provided by galvanized iron ventilators fastened to the concrete by means of expansion bolts.

The cupolas or pent houses built along the center line of the building are provided for ice chutes and elevator machinery. The frame is of structural steel supported by two middle rows of trusses and the wall is made of hard burned tile laid in cement mortar except in those parts carrying the slabs supporting the elevator machinery where they are of hard brick laid in cement mortar. The roof on the cupolas is of reinforced concrete covered with a composition roofing of tar and gravel similar to that on the main roof.

Each compartment is provided with an elevator operated by an electric hoist. After considerable investigation it was decided to use a direct-connected worm-gear type manufactured by Lee & Hoff Mfg. Co., St. Paul, Minn., with all machinery placed on top of the hatchway. These elevators are equipped with all possible safety devices and are driven by 11 h. p. slip ring induction motors, 3-phase, 60 cycles, 220 volts, using external grid resistance in starting, allowing a starting current of 150 per cent of full load running current. The capacity is 2,000 lb. at a speed of 75 ft. per minute. The cars are constructed of steel and are designed to unload the ice automatically into the chute at the top of the building. The elevator shaft is made of structural steel and is designed to resist any lateral displacement of the ice that may take place. It also carries the guides for the elevator cars. No equipment is furnished for filling the ice house, as this is all done by the contractor who supplies the ice. One steel ladder is provided for each compartment. These ladders are attached to the division walls by means of angles which run horizontally through the walls and project about one foot beyond and to the ends of which the ladders are bolted.

Ice chutes run from each elevator to openings in the side walls just above the ceiling slab where the ice is delivered to spiral gravity chutes which carry it to the icing platform. The ice chutes are made of wood supported on wooden bents placed from 10 to 14 ft. apart and having a minimum fall of 1 in 20. The 2 in. x 2 in. oak strips forming the bottom of the chutes are protected from wear by 1 in. x ¼ in. half oval steel strips.

On the west side of the building, one door is provided for each compartment for filling purposes and to give easy access from one compartment to another, each division wall has a door 3 ft. wide by 20 ft. high located near the center line of the building. The outside doors are double and are constructed of four thicknesses of ¾ in. boards—two on the inside and two on the outside—with a 2½ in. air space between. Two layers of waterproof paper were laid between the ¾ in. boards. The doors are hung on heavy strap iron combination hasps and hinges in sections alternating 4 ft. 4 in. and 2 ft. long. All edges closing against jambs or each other are covered with rubber canvas 1-16 in. thick on a cushion of hair. The outside of the doors is covered with No. 22 gage galvanized steel for fire proofing. To provide additional insulation at the outside doors where leakage is bound to occur two vertical rows of 3 in. channels 9 in. apart were bolted to the column on each side of the door and 1½ in. x 10 in. plank fitted into the grooves of the channels—the space between the plank being filled with regranulated cork. The doors in the division walls are constructed of two thicknesses of 1½ in. x 10 in. plank, each thickness fitted into channels as explained for the outside doors except that the insulation space is somewhat greater. The trap doors in the ceiling are of wood with cork insulation and are covered with galvanized steel. On the inside of all walls 2 in. x 4 in. timbers spaced 2 ft. 6 in. on centers were bolted in a vertical position and 1 in. x 4 in. drip boards with bevelled edges, were nailed to these horizontally to keep the ice and drippings away from the walls.

The question of insulation was given considerable thought. Sawdust which is used for fully 90 per cent of the ice houses built is, at its best, an indifferent insulating material and its affinity for moisture soon renders it worthless unless unusual precautions are taken to keep it dry. Head end cinders make a good insulating material but it was impossible to get enough of them except for the floor. Fine regranulated cork is an insulating material of high efficiency, is moisture repellant and can be bought at a very reasonable price. For these reasons it was decided to use fine regranulated cork for insulation. After the walls were built to their full height the regranulated cork was poured into place and compacted as much as possible by tamping or rather stirring with long poles.

All column and beam reinforcement is of medium steel manufacturers' standard specifications. The column reinforcement consists of four 1⅛ in. verticals with 5-16 in. round ties 12 in. on centers. The verticals were put in place full length and required substantial bracing to hold them in their proper position until the concrete reached a point high enough to fulfill this function. To accomplish this, three forms made of 2 in. x 4 in. timber were used for each column reinforcing. The frames were constructed in the form of a square with a hole large enough to take a column vertical in each corner. The frames were then put on the column verticals near the ends and middle and were hoisted into place by means of a gin pole, after which they were securely braced. Wall reinforcing was made up on the ground into panels 4 ft. high and with a length equal to the distance between columns and was hoisted into place.

All forms were constructed of wood. Those for the walls and columns were made in sections 4 ft. high, a sufficient number being built to extend the full length of all walls. After the concrete had hardened sufficiently, these forms were raised into a new position and used over again. With but slight repairs they lasted for the entire job and were raised on an average of twice a week. The outside forms for the pilasters were built up in 8 ft. sections and left in place for the full height of the walls, but those used to form the insulating space were made in 4 ft. sections and raised at the same time as the wall forms.

Ceiling forms were hung from the trusses and the roof forms were supported on the lower chords of the trusses by means of vertical posts.

A 1:2:4 concrete mixture was used throughout. Bank sand was obtained within a short distance of the site and a very fine grade of gravel was shipped in from a distance of 25 miles. The gravel was run through a ¾ in. screen. Trident Portland cement was used.

The contractor's plant consisted of two Smith mixers of ½-yd. capacity, located one on each side of the building about 120 ft. from opposite ends. A platform long enough to serve seven gondola cars was constructed for each mixer and the cement, sand and gravel were fed into the mixers direct from the cars by means of wheel-barrows. The mixers discharged into steel bucket hoists which in turn dumped into a forebay from where it was taken to the forms by two wheel push carts. A substantial staging 6 ft. wide, of 4 in. x 4 in. timbers and 4 in. x 6 in. timbers for uprights with 2 in. planking was built along all walls.

Construction commenced in the early part of December, 1912, but considerable delay was experienced on account of difficulty in getting materials and some time was also lost on account of bad snow storms. Good progress was not attained till the first of February, but from then on the work went on rapidly and the building was delivered to the Northern Pacific about the first of June.

Considerable freezing weather necessitated the installation of steam pipes between the 4 in. walls, and the water used for mixing the concrete was heated to almost the boiling point and the proper amount run into the mixer. The correct proportions of sand and gravel were then added to the water and thoroughly mixed, after which the cement was dumped in and mixed sufficiently to insure its proper distribution. By using this method concrete was delivered from the mixer at about 90 deg. F. By taking the precautions noted above, no trouble was experienced with frozen concrete. The performance of the plant in preventing loss by melting of the stored ice has been so satisfactory that the owners consider that the economy thus secured pays good interest on the total investment made.

The work was carried on under the direction of W. L. Darling, chief engineer of the Northern Pacific, and the late W. C. Smith, chief engineer maintenance of way. Deeks, Deeks & Smith, St. Paul, Minn., were the contractors, and the consulting engineer was C. A. P. Turner, Minneapolis, Minn., who has applied for patents on this type of construction.

Pennsylvania R. R.

The practice of the P. R. R. is set forth in the following from Mr. C. S. Long, general manager, which states among other facts that the road has no brick or concrete ice houses:—

The two houses described are located at Southport, N. Y., and Mifflin, Pa.

The house at Southport has one room 60x150 ft., with a capacity of 7,000 tons. At Mifflin the ice storage part consists of two rooms, 38x75 ft., each with a capacity of 800 tons.

The foundations at Southport consist of concrete piers, and at Mifflin of stone masonry 18 in. thick and 5 ft. high,—3 ft. of which is under ground. The floor of the Southport house is of clay, while that of the Mifflin house is 3 in. plank on sills embedded in cinders. Both are covered with sawdust. The foundations under the partitions of the Mifflin house are 18 in. x 5 ft. masonry, the same as the outside walls.

In the Southport house the ice is laid on sawdust spread on the clay floor, while in the Mifflin house sills are embedded in the cinders on which is a 3 in. floor covered with sawdust. At Southport the walls consist of studding, with 1 in. German siding sheathing, a 1 in. center partition with a layer of heavy paper, and a 1 in. lining, making a double air space. In the Mifflin house they consist of studding, sheathed and lined with ⅞ in. cypress with a 1 ft. space between, filled with shavings.

There is no ceiling in the Southport house. In the Mifflin house there is a yellow pine tongued and grooved ceiling with tarred joints, covered with two layers of felt. There is no attic in the Southport house, the interior being open to the peak. In the Mifflin house, however, there is an attic space surmounted by a slate roof with a ventilator and openings at the eaves to allow circulation of air. The doors of the Southport house are of siding on the outside with sheathing on the inside. In the Mifflin house they consist of double, beveled swinging doors, packed with shavings.

The platform of the Southport house is 8 ft. wide, placed on the level of the car roofs and extending the full length of the building; that of the Mifflin house is similar, but only 5 ft. wide. There are no platform conveyors at any of our ice houses. The Southport house is filled by means of four electric elevators. At the Mifflin plant the ice is drawn by hand along a platform with gratings on it. Each elevator at the Southport house will handle three tons per hour.

The ice stored at Southport is natural and is drawn up an inclined chute with a hoisting engine to the elevators; that handled at Mifflin consists entirely of artificial ice, placed in the storage rooms by hand when the output is not being immediately shipped. At Southport the cakes average 21 in. square and from 8 to 14 in. thick. At Mifflin they are 22x11x38 in. in size and average 300 lbs. in weight. At both houses the cakes are stored on edge. This practice is followed at all our houses, except where the cakes are too irregular in shape. No spaces are left between the cakes. It is found that when stored on edge there is no difficulty in removing them when required. At all houses a space from 6 to 12 in. is left between the ice and the wall which space is filled with sawdust. The house is filled up to the over-layers in the Southport house. In the Mifflin house the ice is kept several feet below the ceiling to facilitate handling.

At all houses the ice is covered with about 12 in. of sawdust. We have tried strips of wood between layers of ice at our Mifflin plant, but found it unsatisfactory, as the pressure caused the ice to melt until the wood was embedded and the cakes in contact. We do not use paper, sawdust or cork between layers. Our practice is to cover ice in all our ice houses with about 1 ft. of sawdust. Though we have found that wooden shavings give a little better result, they do not warrant the additional expense.

We do not withdraw ice quickly in a short period, except at some of our small houses, where it is done by hand with chutes and platforms. At our Southport house the ice is withdrawn regularly throughout the summer by 4 single-cake electric gig elevators, spaced equally, and is slid along the platform to the car. At our Mifflin plant the operation is usually direct from the freezing pan to the car, there being very few trains iced at this point and practically the whole output being loaded in cars on a siding and shipped to various consuming points on our road. These cakes are slid along the floor to a platform on a level with the car floor. When moved from storage they are handled on chutes and inclines.

None of our ice houses are provided with drainage systems under storage rooms. Any moisture accumulating in the bottom percolates through the earth. In the Mifflin plant the freezing floor on which the pans rest is of concrete underlaid with a 6 in. terra cotta drain.

The walls are not trussed. The roof of the Southport house is constructed of wooden rafters. The roof of the Mifflin house is composed of 4-panel Pratt trusses with bottom chords of two 3 in. x 12 in. yellow pine stringers bolted together, the trusses supporting purlines on which the rafters are placed. These support a slate roof.

The total shrinkage for natural ice at Southport varies between 30 and 40 per cent in a year, while for artificial ice in storage the shrinkage is found to be 10 per cent in six months at Mifflin. In icing trains the ice is distributed along an overhead platform before arrival, making as little delay as possible.

The Southport house cost $17,096, or $2.44 per ton, which is about the average. The Mifflin house, including freezing plant, cost $18,889. The Mifflin freezing plant is the only one on our lines, and it consists of the can system with two machines of 60 tons capacity each, made by the Arctic Ice Mfg. Co., and driven by two 75 h. p. Corliss engines, supplied by three 60 in. locomotive type steam boilers, with hot water feed pump and condenser. The cooling coils consist of 1,132 ft. of 1 in. pipe, with 896 ft. of 1½ in. pipe in the tanks. There are two tanks, each containing 380 cans, 22¾ in. x 11¾ in. x 45½ in., served by one ½-ton crane over each tank. There are two buckets, each with a capacity for two cans, with hot water jets for removing the ice. The water used is provided by a distilled water system of the exhaust steam type. The maximum capacity of the plant is 64 tons per 24 hours, the average being about 50 tons.

Philadelphia and Reading Ry.

The Philadelphia and Reading Railway has not built any ice houses up to the present time, but in anticipation of such construction has made an extended investigation, the results of which Mr. Wm. Hunter, chief engineer, placed at the disposal of our committee as follows:—

Ice storage buildings of wood, or other non-conducting materials, are superior to those of brick, stone, concrete, etc., which fire laws in certain communities require. In such places the house is usually built of wood with the weatherboarding replaced by brick or other fire proof outer walls.

To the extent that outside air cannot find a way through, around, under or over the exterior walls to the inside of the building is the insulation effective, and the shrinkage of the contents reduced. In this climate the foundation walls should bottom not less than 4 ft. below the finished surface of the ground and built as two walls, with occasional bonds between, so as to leave a continuous air space (except for the occasional bonds) of not less than 4 in. width midway throughout; the exterior surfaces to be well coated with hot asphaltum or other water and airproof non-deteriorating composition so as to effectively seal out all air movement and moisture.

The exterior walls of the building should be 2 in. by 8 in. studding spaced 3 ft. centers, sheathed on both sides with planed inch boards,

shiplapped and tightly fitted, with heavy waterproof building paper, running horizontally and lapped half (making a double thickness) on the inside or filling surfaces, and the intervening space tightly packed with perfectly dry soft wood sawdust or fine mill shavings (hardwood dust or shavings are much inferior while dampness decreases its insulating properties).

The interior of the building should be partitioned into rooms so that the warm outside air that unavoidably gets in during withdrawals, can reach only a fraction of the ice area; the partitions between these rooms, resting on foundations similar to those under the exterior walls, but not so heavy or elaborate. They should be of 2 in. x 8 in. studding spaced 3 ft. centers, sheathed on one side only with two thicknesses of tightly fitting planed inch boards interlined with one thickness of damp-proof paper; all joints to be broken with respect to all other joints with outside nails to reach through well into the studs.

There should be no openings of any kind in the partition walls and only one in one of the exterior walls of each room, that to extend from the floor to 3 ft. above the storage limit point, through which to receive and withdraw the ice. This opening should be closed with two rows of 1½ in. x 6 in. planed sheathing boards sliding in guides, one near the outer and the other near the inner edge of the opening, the intervening space to be filled with dry sawdust or fine shavings as the storing of the ice progresses. Each room should be fitted with an airtight gabled ceiling placed a few feet above the top of the storage limit (just enough space to permit the finishing of the storing). This ceiling should be covered with roofing paper, dry sawdust or fine mill shavings.

The floor construction is of special importance; cement or other solid floors are not good as outside air leaks in through the drains, even when well trapped. A very small amount of air through the floor causes much loss. Thus far the best results have been obtained by digging a well 12 ft. in diameter in the center of each room and not less than 5 ft. deep, depending on the seepage capacity of the strata penetrated, filling it with ill-shaped stone, so as to obtain a large void content. The entire floor of each room, including that over the well, should be made of fairly absorbent earth, compacted to eliminate all yielding spots, and sloped uniformly towards the well so that the center will be 4 in. lower than at the wall. Eight inches of fine dry planing mill shavings should be spread over this and 2 in. plank spaced ¼ in. apart laid thereon. The water from the ice, if any, seals out the air while it seeps into the blind well, and the slight tilting of all the ice toward the center prevents any ice pressure ever getting on to the walls, if the ice is stored and withdrawn as hereafter described.

The building should be covered with an ordinary flat roof placed 8 ft. to 11 ft. above the plate, without ventilating or other openings therein, and the space between the ceilings of the rooms and the roof should be enclosed by an ordinary board fence, on top of the exterior walls, made of planed inch boards placed vertically, and spaced about ¼-in. apart. If unseasoned boards are used their edges can be loosely butted. No ventilating device—no matter how elaborate—has produced results equal to this.

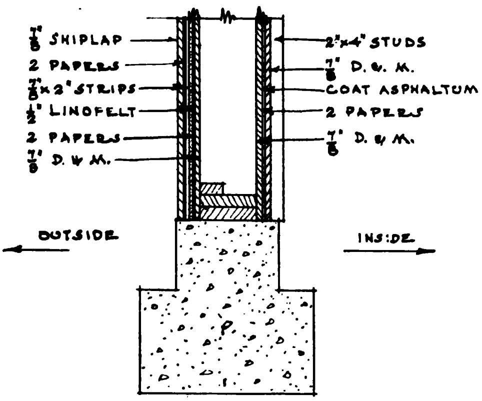
The final results are greatly modified by the arranging of the ice in storing. If it is stored in uniform tiers, the length of the cake being the width of the tier, with an air space of 4 in. (6 in. is better than 3 in.) between each tier extending the entire length and height of the room, and the cakes in each layer breaking joint with those beneath, the ice can be stored and withdrawn at minimum cost and waste, and the shrinkage from melting will be very little, if any. By starting to withdraw the ice at the door end of each tier, breakage is almost entirely avoided. Only sufficient opening, and that curtained, should be made in the exit to properly pass out the ice. Each layer throughout the entire length and width of the room should be entirely removed before the one beneath is attacked, and one room should be entirely emptied before another is

opened, the end rooms being the first to be emptied. An empty room should remain closed as long as the adjoining one has ice in it and the withdrawals should be made in the shortest time possible. No straw or other covering is required for the ice as the airtight ceiling protects it effectively. Electric or other illumination must be provided for each room when work is being done therein.

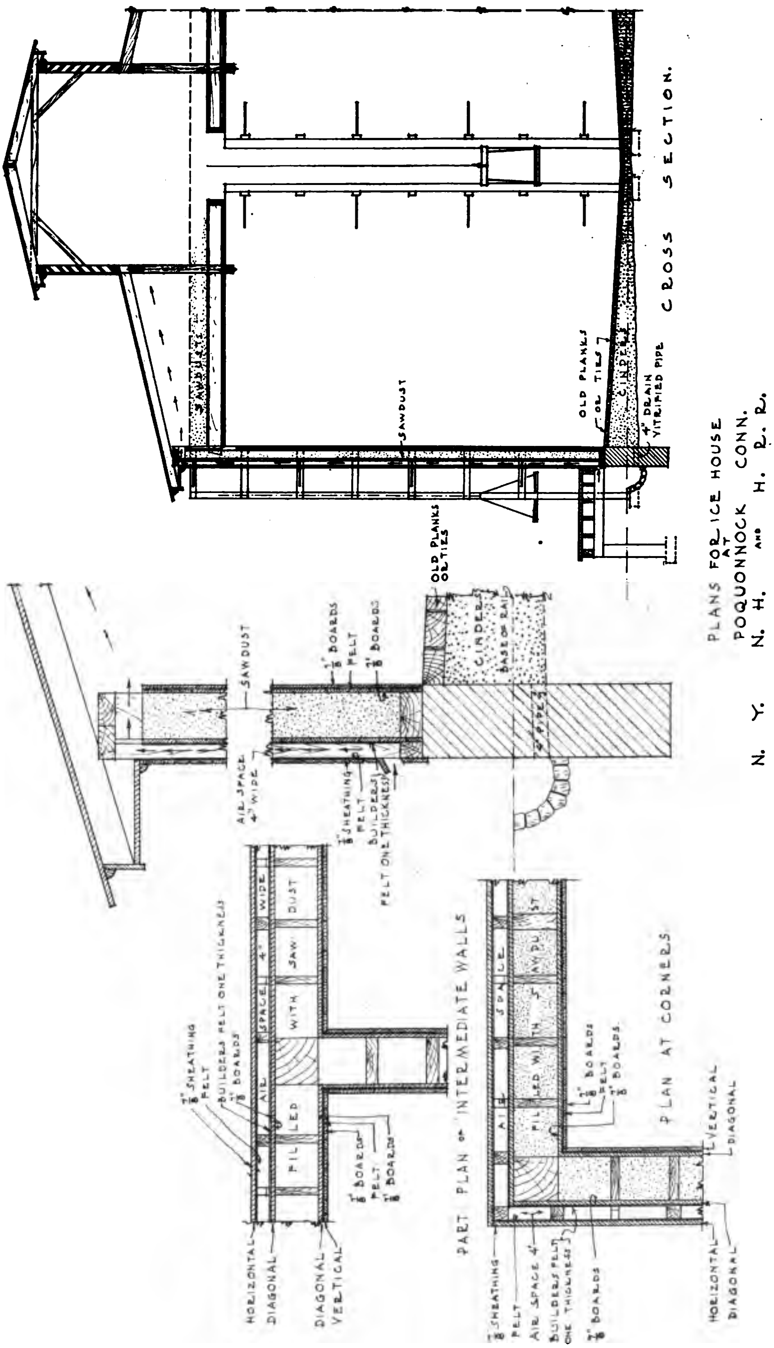
The building should be so set that the top of the floor will be but a few inches above the surrounding surface of the ground, at all events none of the foundation walls should be in direct contact with the air. Rough lumber attracts and holds much more moisture on the surfaces than does planed, yet the cost is the same in the completed structure.

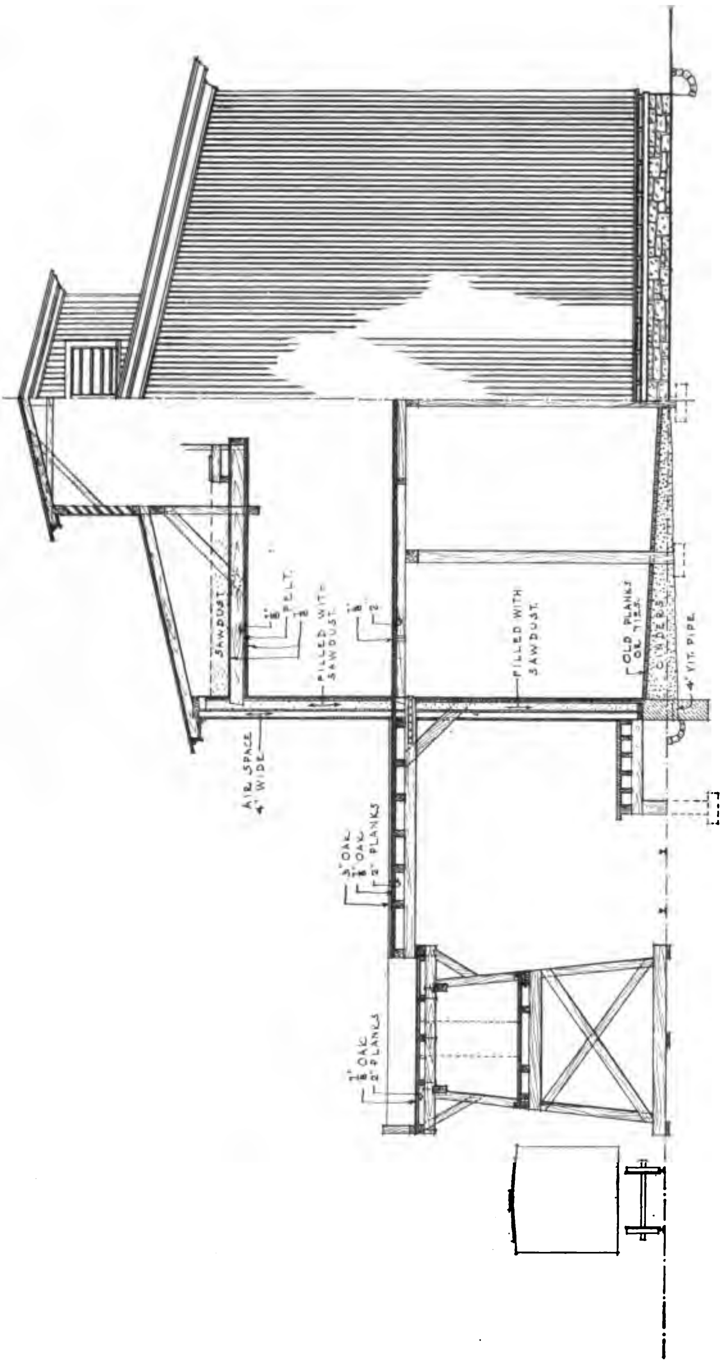
For a natural ice storage house best suited to our requirements and working conditions, and one in which the cost, operating expenses and shrinkage can be reduced to a minimum, based on the foregoing facts, I would suggest a wooden building containing 14 rooms, each 36 ft. wide, 90 ft. long, and 40 ft. high, net storage space; higher than this unduly increases the cost of power, machinery, storing, and withdrawing, and is not justified unless the value of the land is so high that the area must be restricted. The outside dimensions of such a building will be 517 ft. 4 in. long, 91 ft. 8 in. wide and about 51 ft. high from top of floor to under eaves, and will hold 40,000 tons of ice. All lumber except that on the exterior should be either cypress or creosoted pine; if the latter, all surfaces should be clear of free preservative.

This building would not be the best for storing manufactured ice as that is an entirely different problem.



WALL SECTION
PROPOSED ICE HOUSE
THE CUDAHY PACKING CO.
SO. OMAHA


CROSS SECTION.
SAWDUST
OLD PLANKS OR TIES
CINDERS
4" DRAIN VITRIFIED PIPE
AIR SPACE 4" WIDE
7/8" BOARDS
FELT
7/8" SHEATHING
BUILDERS FELT ONE THICKNESS
BASE OF RAIL
4" PIPE
HORIZONTAL
DIAGONAL
VERTICAL
AIR SPACE 4" WIDE FILLED WITH SAWDUST
PART PLAN OF INTERMEDIATE WALLS
PLAN AT CORNERS
PLANS FOR ICE HOUSE AT POQUONNOCK CONN.
N. Y. N. H. AND H. R. R.

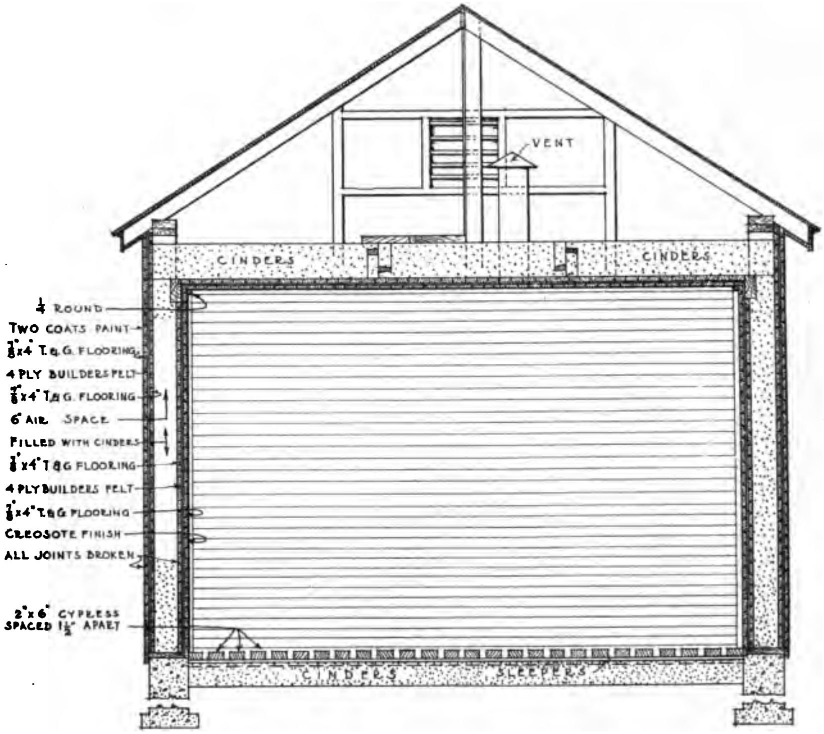


ONE-HALF END ELEVATION.

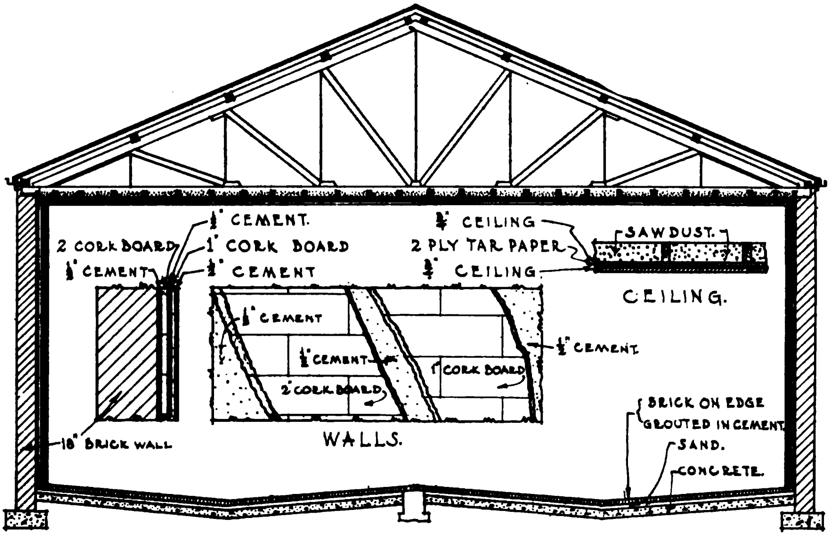
CROSS SECTION.

PLANS FOR ICE HOUSE AT POQUONNOCK CONN.

N. Y. N. H. AND H. R. R.



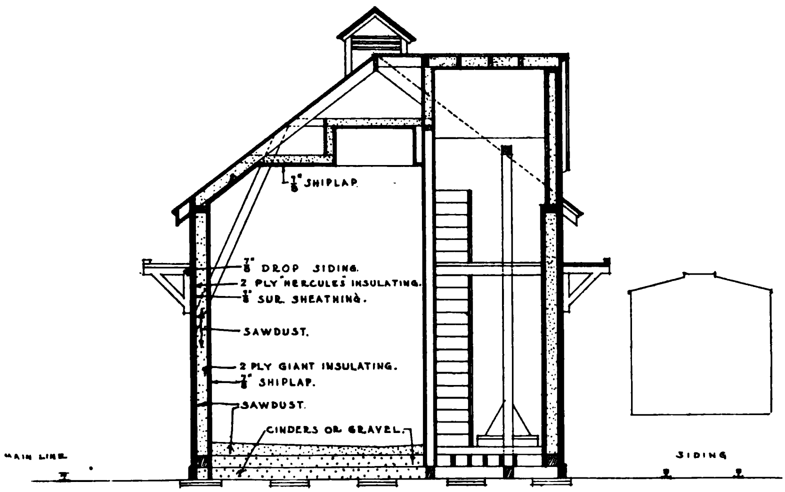
CROSS SECTION.
STANDARD ICE HOUSE
OF
ST. LOUIS & SAN FRANCISCO R.R.CO.



CROSS SECTION.

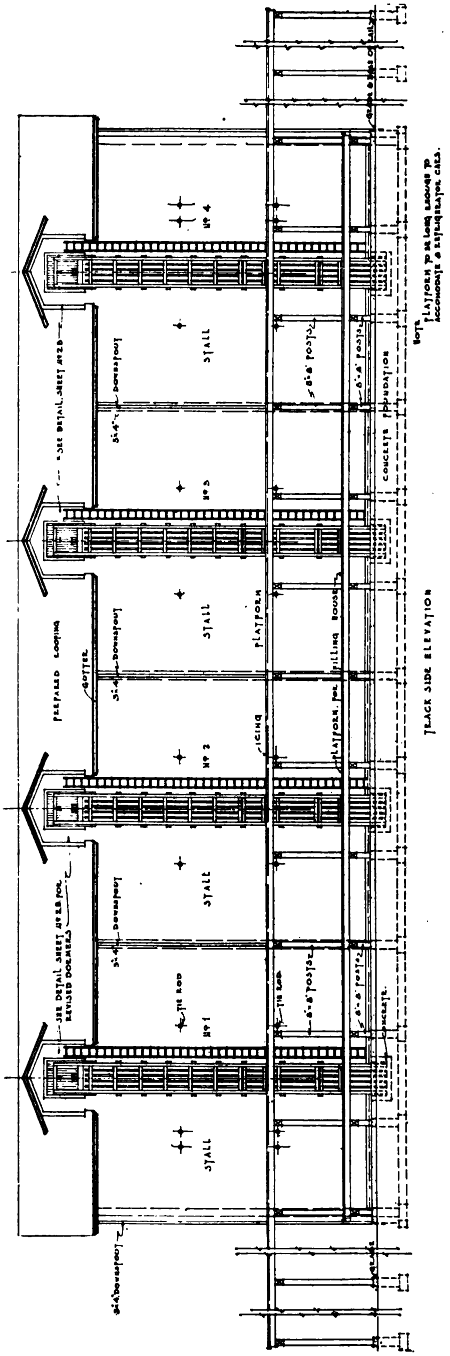
BRICK ICE HOUSE PROPOSED BY THE

MOBILE AND OHIO R. R. CO.

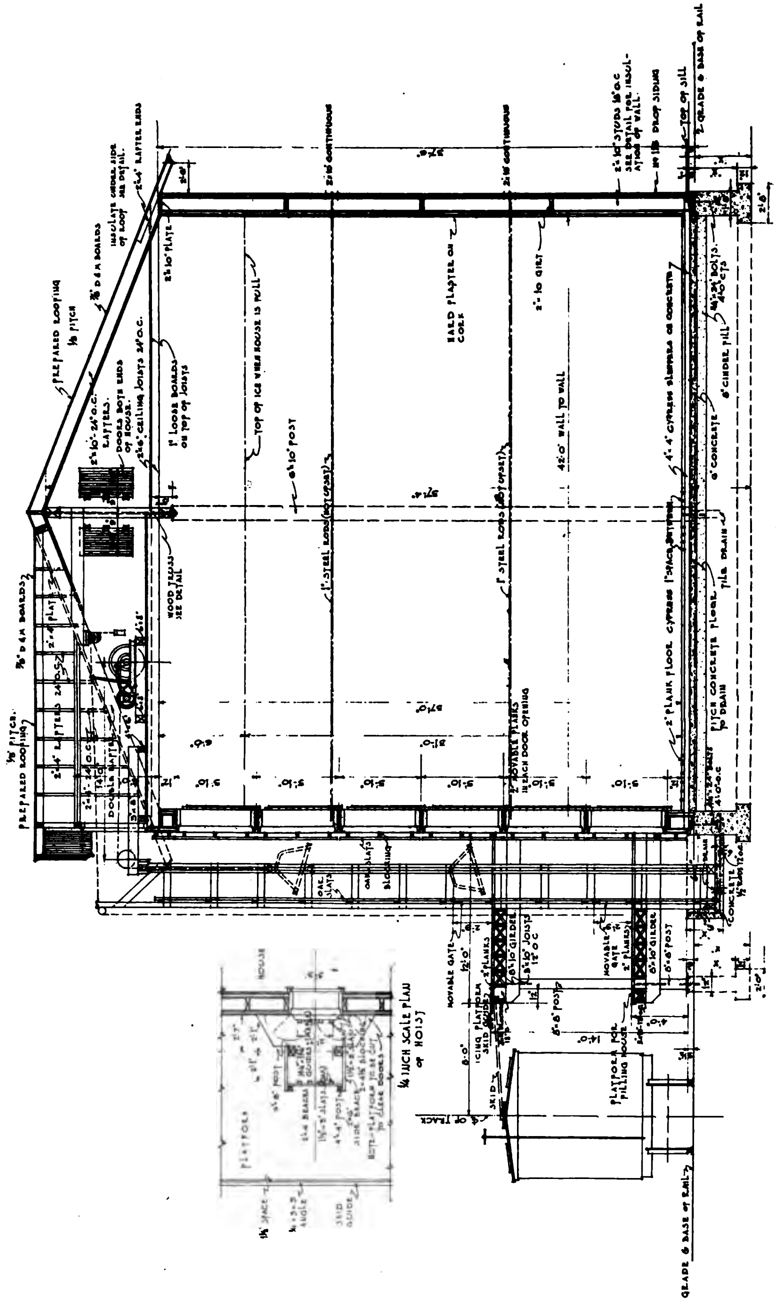


SECTION.

Standard 500-Ton Ice House, Canadian Northern Ry.

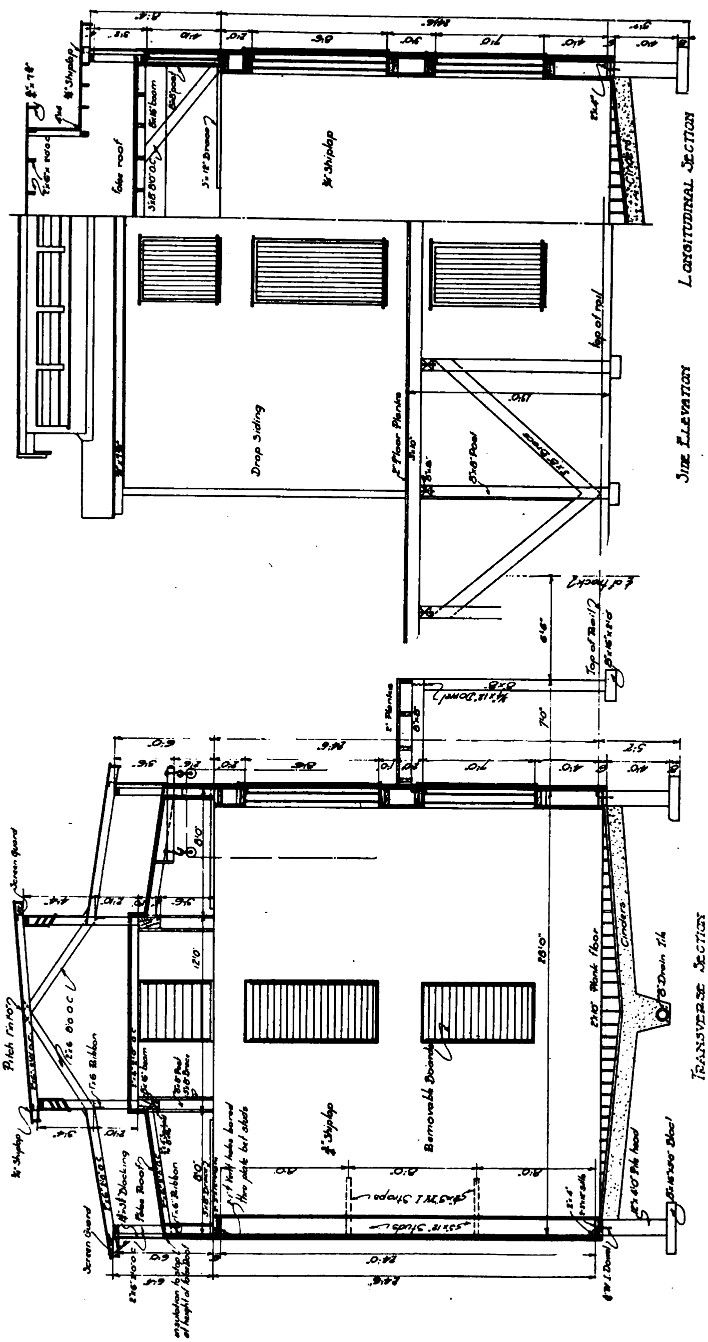


Track Side Elevation, Illinois Central Ice House at Centralia, Ill.

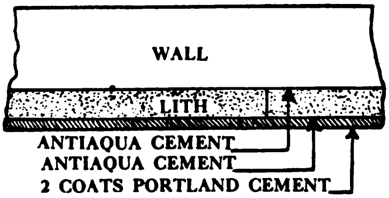


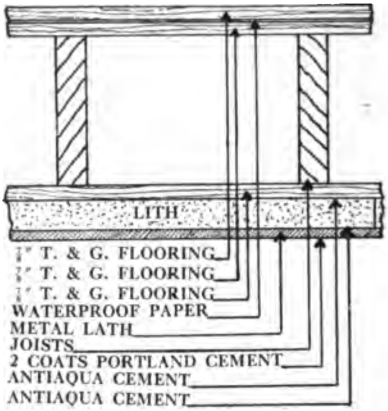
CROSS SECTION

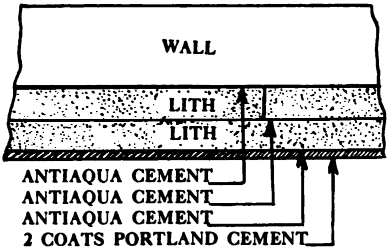
Cross Section, Illinois Central Ice House at Centralia, Ill.

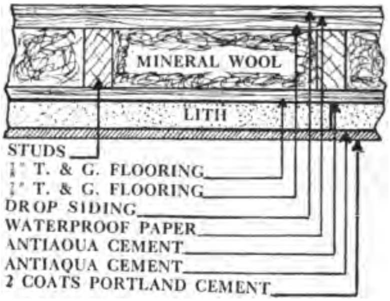


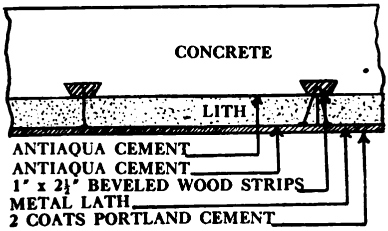
Standard 300-Ton Ice House, Chicago, Milwaukee & St. Paul Ry.

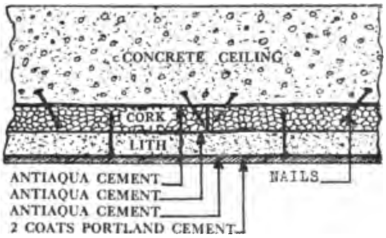


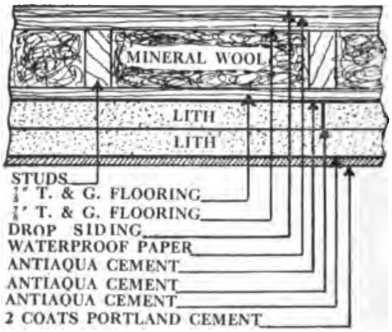












Typical Designs for Insulation of Walls and Ceilings for Refrigeration.
(Union Fibre Co.)

DISCUSSION.

(Subject No. 1, Railroad Ice Storage Houses.)

Mr. Hadwen:—I have not read the letters in the back part of this report, but one thing struck me when hearing the report read. I should like to ask if any of the members present are prepared to compare data relating to their percentage of loss with that shown by the packing houses. They say they are able to keep their shrinkage down to 4 per cent. How does this average compare with the loss for the different types of ice houses being used on the various roads?

The President:—The percentage of loss shown by this report is extremely low. I dare say that some of you are losing more than 4 per cent.

The Secretary:—There is no question but that the loss depends to a great extent upon the character of the house and the care which the house receives, with reference to keeping it tightly closed, etc. It also depends to some extent on the size of the house.

I wish to call attention to the statement made by Mr. Pettis, of the New York Central, in the report where he refers to the more expensive type of houses; he states that in many cases the construction is too elaborate and expensive and that a cheaper style of construction might answer the purpose almost as well. Some of the more expensive houses cost from $5 to $6 per ton of storage.

The Northwestern recently built an ice house at Green Bay, Wis., with about 18,000 tons capacity, containing 10 rooms, each 32 ft. by 63 ft. at a cost of $28,000, or about $1.55 per ton storage capacity. This house is referred to in the report under discussion.

A novel method was employed in the construction of the Green Bay house, which is described by Mr. Pole, assistant engineer, as follows:

In constructing the Green Bay ice house we made a deviation from the usual procedure in the erection of structures of this size, in that all the exterior walls and interior cross-walls were previously constructed on the ground in a practically horizontal position and then hoisted into their vertical positions. The foundations having been completed up to and including the base

sills at the ground level, the side-wall and cross-wall sections were then assembled on the ground in a horizontal position, the studding being placed with the heel on the sill and the soleplate to hold them spaced at the bottom and the ceiling plate fastened in position at the other or upper end.

The insulating partition and papers and the inside sheathing or boarding were then nailed in place, composing sections 32 ft. by 40 ft. in size,—the 32 ft. dimension being the length of the bay or the distance between cross-wall sills, of which there were 10 on one side,—and the 40 ft. dimension the height under the eaves of these sections or side-walls. The cross-walls, 64 ft. long and 40 ft. high, were built in a slightly inclined and over-lapping position as their height was greater than 32 ft. the distance between the center of their sills.

All the sections of the exterior walls and cross-walls were completed in their respective horizontal positions. The erection was then commenced, beginning at one end of the building by raising the end-wall and the first cross-wall and one panel each of the sidewalls, by means of a 60 ft. gin-pole and a hoisting engine. The 32 ft. sections weighed about 3 tons and the 64 ft. sections about 7 tons each. One compartment was enclosed in one day. The sections were interlocked and tied together by keyed joints and the roof trusses in such a manner as to be just as rigid as though they were erected in a vertical position in the usual manner.

As soon as the erection of the sections was completed, the roof trusses were placed and the ceiling and roof work proceeded in the usual manner; the trusses, ceiling and roofing purlins and boarding being hoisted up before the gin-pole was removed for the erection of the next compartment. Other work followed immediately including the placing of the exterior drop siding, platforms, etc.

This method of construction proved to be very rapid and economical. It was much cheaper to place the sheathing on the studding when on the ground than when one has to employ scaffolding, etc., as is required when the studding is erected in the usual manner. Also, there is less chance of injury to men by accident than when working on a high scaffold.

Subject No. 2.

WARNINGS FOR OVERHEAD AND SIDE OBSTRUCTIONS.

REPORT OF COMMITTEE.

There is no doubt as to the necessity and value of giving warning to men on the top and the side of cars, when a train is approaching some overhead or side structure or tunnel with less than the requisite clearance to pass the tallest man on top of the highest car, or with less than the proper room on the sides. The appliances for giving such warning are known by various names, such as bridge warnings, bridge guards ticklers, tell-tales, whip cords, indicators, etc. The general principle is the same in all cases. Some appliance is suspended or swung across the track or tracks near the obstruction in such a manner as to strike a man a light blow and thereby warn him of the approach of a low bridge, tunnel, or other overhead structure.

Different systems are employed to accomplish the result desired. That most extensively used, and which for convenience will be designated as the vertical rope system, consists of light vertical ropes or wires, known as tell-tales, whip cords, ticklers, or danglers, suspended over the tracks from a rigid horizontal wooden or iron bar, or hung from a flexible wire or cable; the bar or cable being suitably supported on the outside of the track or tracks by upright posts set in the ground and properly braced and back-stayed. This arrangement is used for two or more tracks. For single track, an arm is extended from a post, with a counterweight or brace, and the same style of warning can be used. Sometimes a whip is used instead. The ropes are generally spaced from 3 to 10 in. apart for a distance of 5 to 8 ft. across each track; the lower ends are usually specified to be about 6 in. lower than the lowest point of the overhead structure for which they are to give warning.

One of the important essentials is to prevent the ropes from becoming entangled or thrown over the support by winds, engine exhaust, or more particularly from being tossed up by trainmen in such a manner as to remain hanging on top of the frame, bar, or cable. This is one of the greatest objections to the danglers. It can be overcome in a number of ways, several of which are indicated by the plans accompanying this report.

The warning should not be too far from the structure, as there is too much chance for a brakeman to rise up on the car between the warning and the bridge or obstruction. The distance should certainly be limited to about 200 ft., and in yards where much switching is done immediately under an overhead structure, the location should be closer, say between 100 and 150 ft. Bridge warnings should be used at all overhead obstructions with less clearance than 21 ft.

The advantage of using a cable is that it can span a number of tracks; but it has the disadvantage that it is liable to sag, and requires a good truss cable with turn-buckles, so that it can be tightened up from the ground. The post requires good back-staying, or it should be made strong enough to avoid the necessity of a back stay. In many locations there is not sufficient room to use these stays.

It is also important from the maintenance standpoint to arrange the drops so that they can be repaired easily, if torn off, tied up, or knotted together by brakemen standing on cars, temporarily halted under the

warning. As a rule brakemen will not allow the opportunity to go by without doing something to injure the drops, because they do not seem to realize the importance of these bridge warnings, which are put up for their protection as well as for that of the railroad company.

A number of railroads use galvanized wire screens from which are suspended wire or rope drops. No doubt the wire screen with drops makes a good warning, but it is more or less expensive on account of the rusting of the wire screen. Some use wire drops only; these are very easily bent, thus becoming dangerous to trainmen. Others use the iron rods to which are attached rope drops; these should not be longer than the rods or they will catch and hang over the top of the cable or cross arm. The last mentioned are less dangerous as well as easier and cheaper to maintain.

The committee concludes that the vertical rope system is the best under most circumstances, although there are many trivial modifications of it in use. The committee presents a plan and explanation of the style which would give good results, and recommends its adoption for general use, using, for two or more tracks, steel poles not less than 8 in. in diameter at the bottom tapering to 5 in. at the top, set in concrete; 3/8 in. solid copper, copper-covered pliable steel (six strand), or galvanized wire rope spanned between the poles at a height of not less than 21 ft., and wooden heads fastened to the cable with hanger clamps. At the lower side of the wooden heads are placed dished washers (a preventive against the drops being thrown over the top of the truss cable) held in place by eye-bolts to which are attached 1/4 in. rods. To these rods are fastened 1/2 in. or 5/8 in. Manila rope drops, the length of which is governed by the least clearance of the obstruction. The truss cable should be supported by saddle-caps on top of poles and extended down the back side of the pole to a point about 5 ft. above the ground where it is attached to a turn-buckle fastened to the pole by means of a clamp, thereby enabling one to tighten the truss cable while standing on the ground.

The approximate cost of a warning for one approach, in place, is as follows:—

Four tracks, one approach, material, $127; labor, $48; total, $175.

For single track the same style of pole may be used by having a longer wooden head and a 2 in. wrought iron pipe for a brace. The approximate cost of warning for one approach, in place, is as follows:—

Single track, one approach, material, $58; labor, $28; total, $86.

For side clearance, several railroads use an iron post to which are fastened a number of wooden blades, with rubber ticklers on the ends. The wooden blades are fastened to a rod which is operated by springs on both sides so that when a man comes in contact with the blades it will swing either way and come back to its proper position. Another style of side warning consists of an iron post around which are fastened several rings of rubber garden hose, forming a cylinder about three feet in diameter to which a number of three-strand tarred marlines are attached vertically. This cylinder revolves when it is hit by a man on the side of a car. The details of these will be shown in one of the cuts.

APPENDIX.

A description of bridge warnings from data furnished by members of the Association.

The Philadelphia & Reading uses for two or more tracks two iron poles with back stays and two 5-16 in. galvanized wire cables fastened together in the center to form a truss. To the lower cable wooden ash heads, 1 1/2 in. by 2 1/2 in. by 6 ft., are attached and from brass eyelet screws, which extend through the wooden heads, are suspended wire drops made of spring brass of No. 12 English gage. The length of these is 4 ft. 10 in. The cost of this warning in place is $88. For single track they use one iron bracket pole and the same style of warning, the cost of which is $41.

The Pennsylvania Railroad uses for two or more tracks two steel poles with 3/8 in. copper wire to which wooden heads, 1 3/4 in. by 3 in. by 10 ft., are fastened. From these are suspended 1/4 in. rods to which 1/2 in. Manila rope drops are attached.

The cost of the above described warning in place is as follows:—

Two steel poles and fixtures,	$127.00
Concrete pole foundation, including excavating, shoring and casing,	52.50
Delivering material,	9.00
Labor erecting,	38.25
Painting,	3.00
Total,	$229.75

For single track,—one steel bracket pole is used with the same style of warning. The cost for erecting a single track warning, one approach, is as follows:—

One steel bracket pole and fixtures,	$ 58.15
Concrete pole foundation, including excavating, shoring and casing,	27.00
Delivering material,	5.00
Labor erecting,	20.75
Painting,	1.40
Total,	$112.30

The D. L. & W. uses, for two or more tracks, two iron poles with back stays and two galvanized wire ropes fastened together in the center to form a truss. To the lower cable are fastened wooden ash heads, 1 1/2 in. by 2 1/2 in. by 6 ft. 3 in. Through these extend brass eyelet screws from which are suspended wire drops made of spring brass, No. 12 English gage. For single track they use an iron pole with an extended arm, counterweight style, to which is attached a wire screen made of No. 10 wire with a 1-in. mesh. From this are suspended 5/8 in. bell cords.

The Rock Island uses, for two or more tracks, two wooden poles with back stays and two 1/2 in. steel cables forming a truss. A wire screen 3 ft. by 7 ft. with a 1 in. mesh, is attached to the lower cable. From this are suspended 3/8 in. ropes spaced 6 in. center to center. For single track one wooden pole with an extended arm is used with the same style of warning.

The C. St. P. M. & O. uses two wooden poles with a head piece extended across the top for single and double track (being connected at the center for the latter). To this is attached a woven wire mat from which are suspended No. 9 straight galvanized wires 4 in. centers.

The B. & O. uses two iron poles with two 3/8 in. copper covered cables fastened together in the center to form a truss, for two or more tracks. To the lower cable are fastened screens of No. 10 wire and a 1 in. mesh, from which 1/2 in. Manila ropes on 3 in. centers are suspended. For single tracks they use one iron pole with an extended arm erected counterweight style. To this is fastened a wire screen from which are suspended 5/8 in. Manila ropes.

The N. Y. N. H. & H. uses for six tracks two iron lattice poles with two 1/2 in. cables, fastened together in the center to form a truss. To the lower cable are attached wooden white pine heads, 1 1/2 in. by 3 in. by 11 ft., from which are suspended 3-16 in. galvanized wire drops. To these are attached 1/2 in. tarred ratlines. For single tracks one wooden pole is used with an extended arm and guy wire with the same warning as used for six tracks.

The C. G. W. uses for single track two iron poles with a 2 in. pipe head. To this is fastened a wire screen of No. 10 wire, with a 1 in. mesh, from which are suspended 3/8 in. bell cords on 3 in. centers. They also place signs on the end of high platforms where the clearance is small. (See illustration.)

The M. & St. L. uses for single track one iron pole with an extended arm through the center of a galvanized iron wire net, of 1 in. mesh and No. 12 wire, from which are suspended ⅜ in. sash cords.

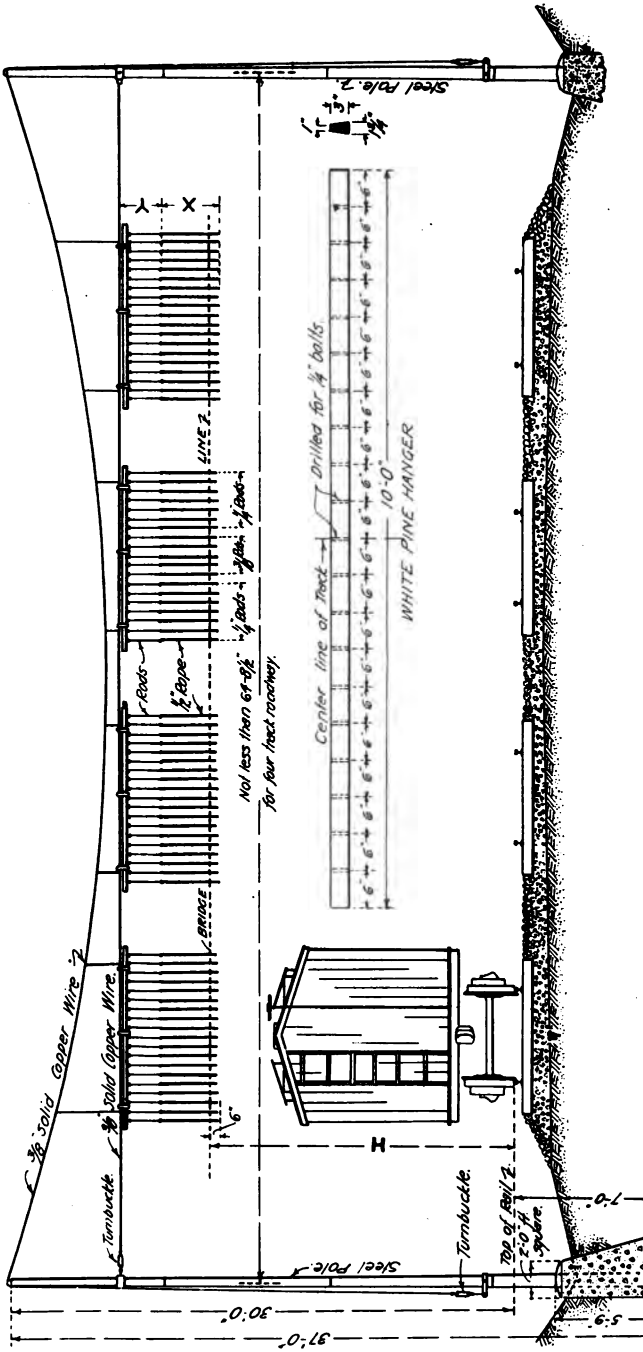
The N. Y. C. & H. R. uses for two or more tracks two iron poles with back stays and two ⅝ in. galvanized wire ropes fastened together in the center to form a truss. Wooden ash heads, 1½ in. by 2½ in. by 6 ft. 3 in., are attached to the lower rope and spring brass drops of No. 12 English gage are suspended from the brass eyelet screws. For single tracks one iron pole with extended arm is used with the same style of warning as for more tracks.

The C. B. & Q. uses for single and double track two wooden poles with three 1 in. galvanized wire ropes to which are attached No. 14 galvanized wire screens of 2 in. by 4 in. mesh, from which are suspended ⅜ in. hemp rope drops. For side clearances they use two styles: First, an iron pole is fastened on a concrete base with rubber ticklers attached to white pine blades. The latter are fastened to a 1 in. galvanized iron pipe which is attached to an iron pole with a spring arrangement, allowing it to swing freely. Second, an iron post is fastened to a concrete base around which are fastened a number of ½ in. garden hose to form a cylinder supported at the top and bottom with springs to which are fastened a number of three-strand tarred marline cords.

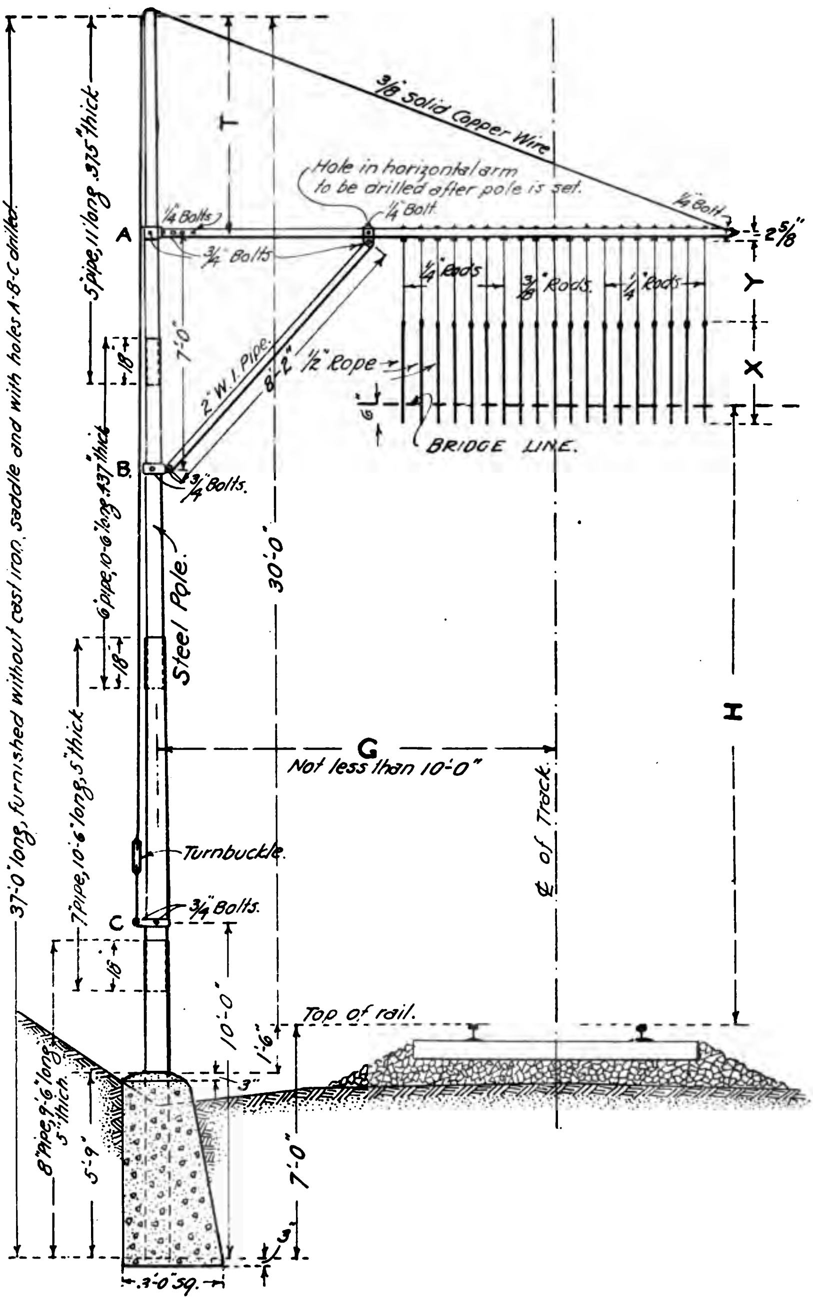
The Lehigh Valley uses for two or more tracks two steel poles with ⅜ in. galvanized stranded rope, to which are fastened oak heads 6 ft. 8 in. long, from which are suspended No. 8 wire drops. The cost of the above described warning in place, for four tracks, single approach, is $166. For single track, one approach, $76.

E. G. Storck, Chairman.
F. E. Schall,
T. E. Thomas,
M. M. Barton,

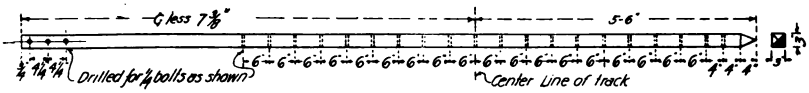
Committee.



Standard Bridge Warning, Pennsylvania R. R.



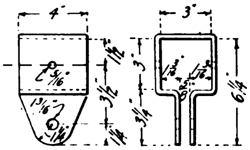
Standard Bridge Warning, Pennsylvania R. R.



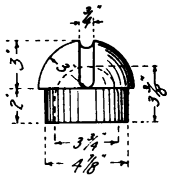
WHITE PINE ARM

TABLE OF DIMENSIONS
Showing values of X, Y & T
for various heights "H"

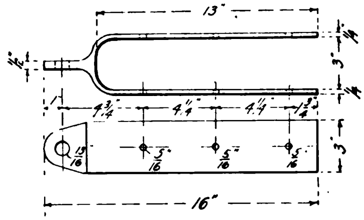
H	X	Y	T
20-6	3-0"	2-6	4-3⅜
20-3"	3-0"	2-6	4-6⅜
20-0"	3-0	2-6	4-9⅜
19-9	3-0	2-6	5-0⅜
19-6	3-0"	2-6	5-3⅜
19-3	3-0	2-6	5-6⅜
19-0"	3-0"	2-6"	5-9⅜
18-9"	3-0	2-6	6-0⅜
18-6	3-0	2-6	6-3⅜
18-3	3-0	2-6	6-6⅜
18-0"	3-3"	2-9	6-3⅜
17-9	3-6	3-0	6-0⅜
17-6	3-9	3-3	5-9⅜
17-3	4-0	3-6	5-6⅜
17-0"	4-3	3-9	5-3⅜
16-9	4-6	4-0	5-0⅜
16-6	4-9	4-3	4-9⅜
16-3	5-0	4-6	4-6⅜
16-0	5-3	4-9	4-3⅜



WROUGHT IRON COLLAR

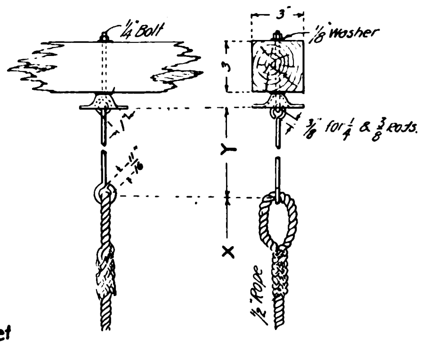


CAST IRON SADDLE.

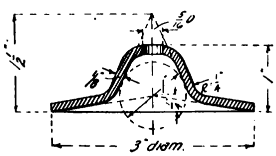


WROUGHT IRON ARM CLAMP.

NOTE
Warnings are necessary for all bridges when underside of superstructure is less than 20-9" above top of rail.
Warnings to be erected over all tracks on both sides of a bridge.
Distances H & G must be specified on all requisitions.
Manufacturers to deliver all Steel Poles, drilled for three ¾ inch bolts as shown.
Joints to be swaged and shrunk.
The 5-9" portion of pole set in concrete foundations to be free from grease or paint.

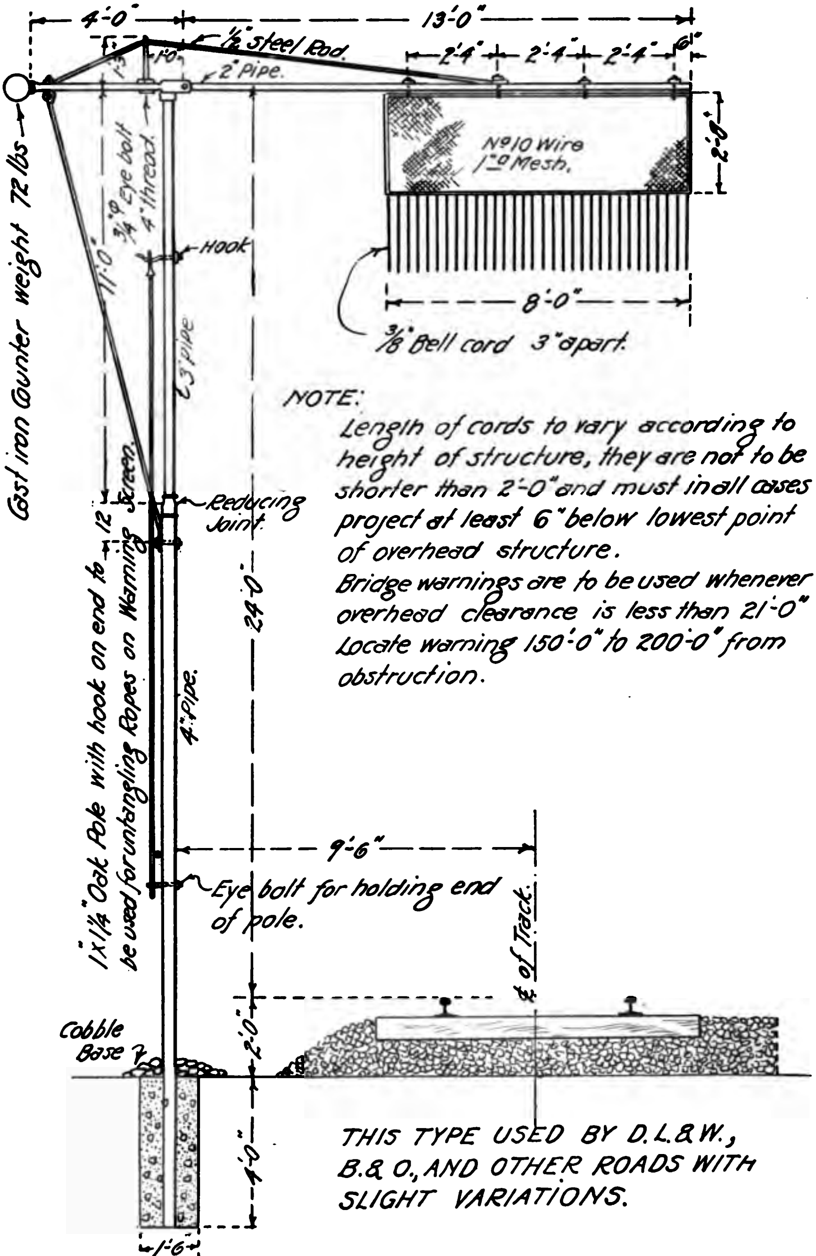


ROPE ATTACHMENT

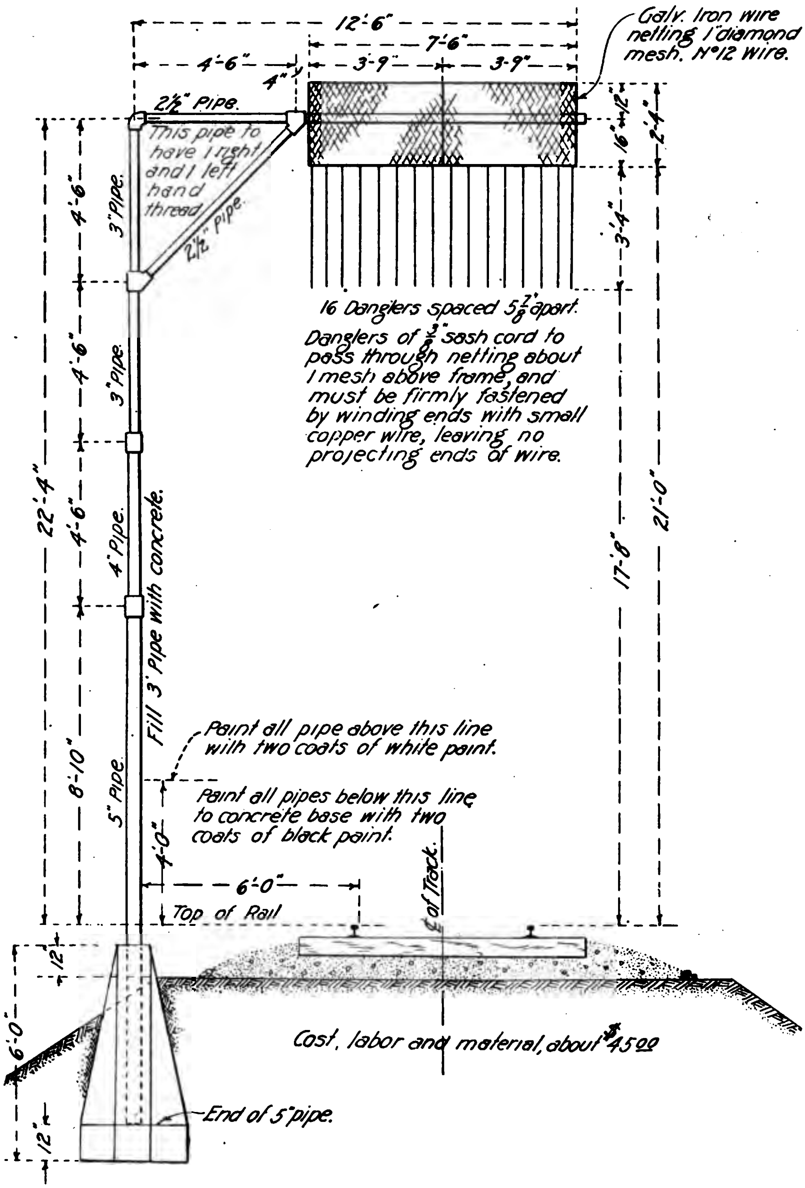


SECTION OF DISH WASHER

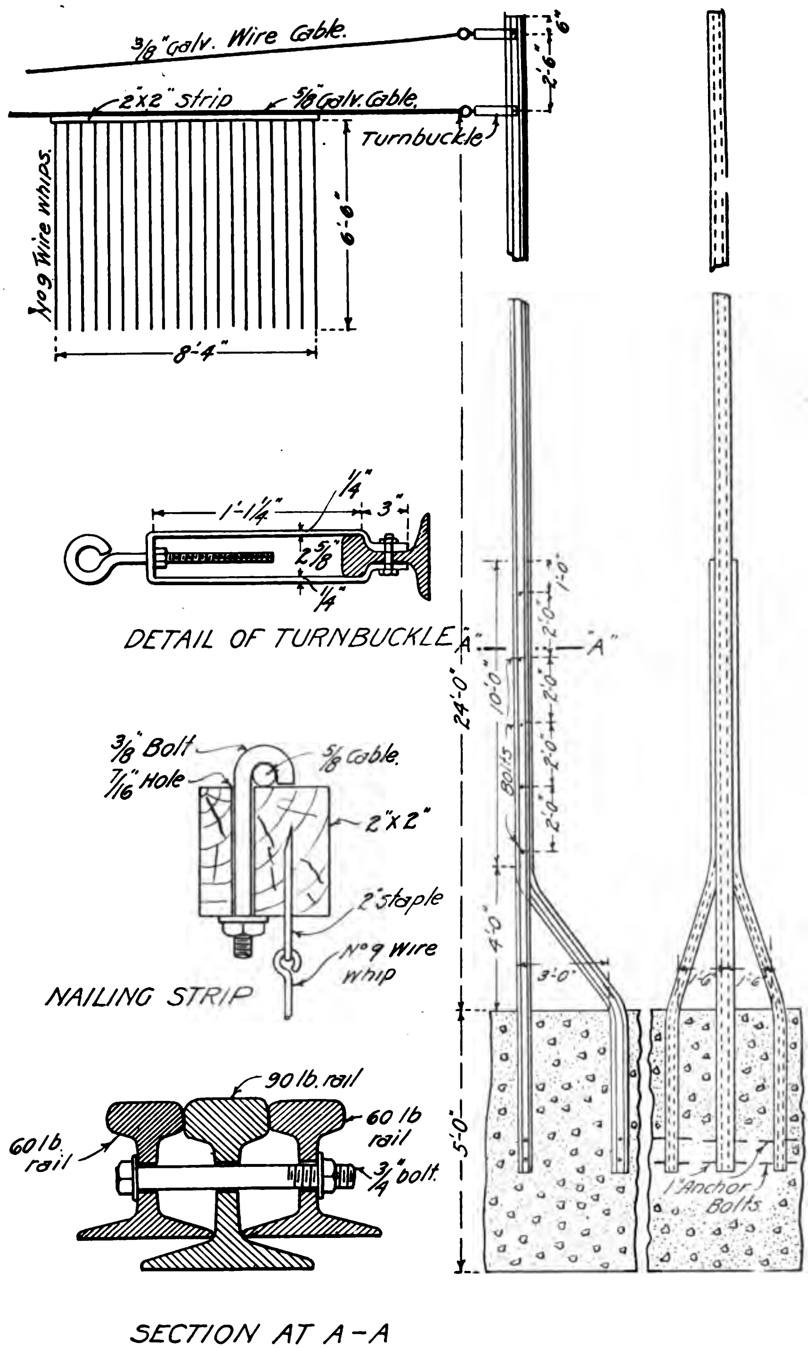
Details, Standard Bridge Warning, Pennsylvania R. R.



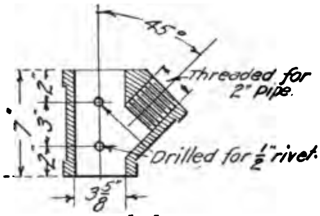
Standard Warning, Delaware, Lackawanna & Western R. R.



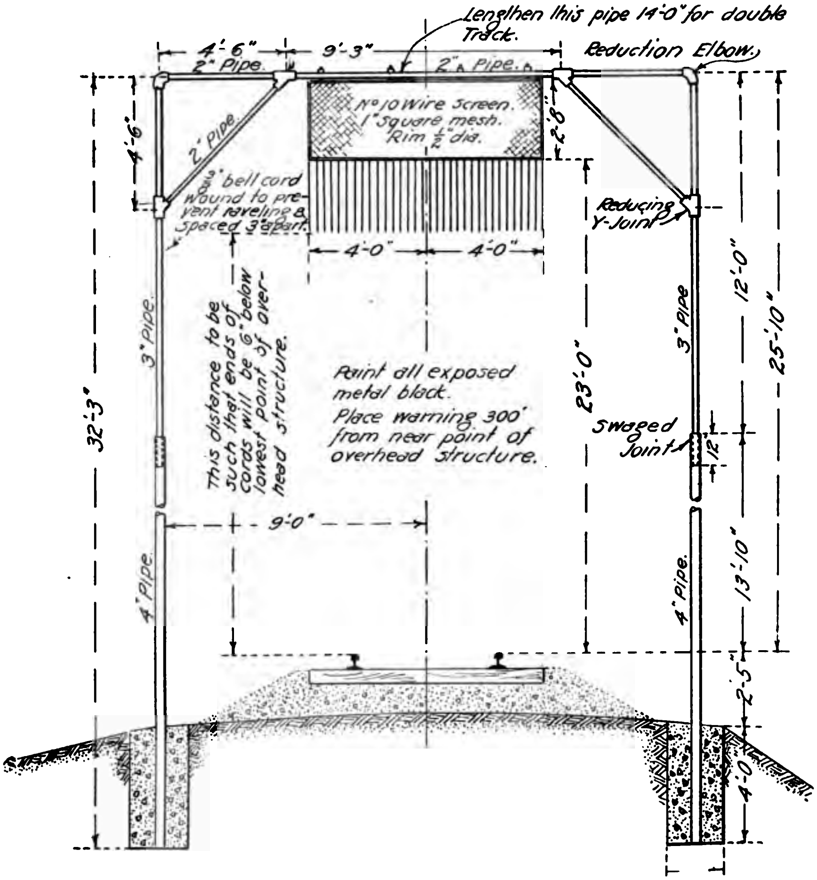
Bridge Warning, Minneapolis & St. Louis R. R.



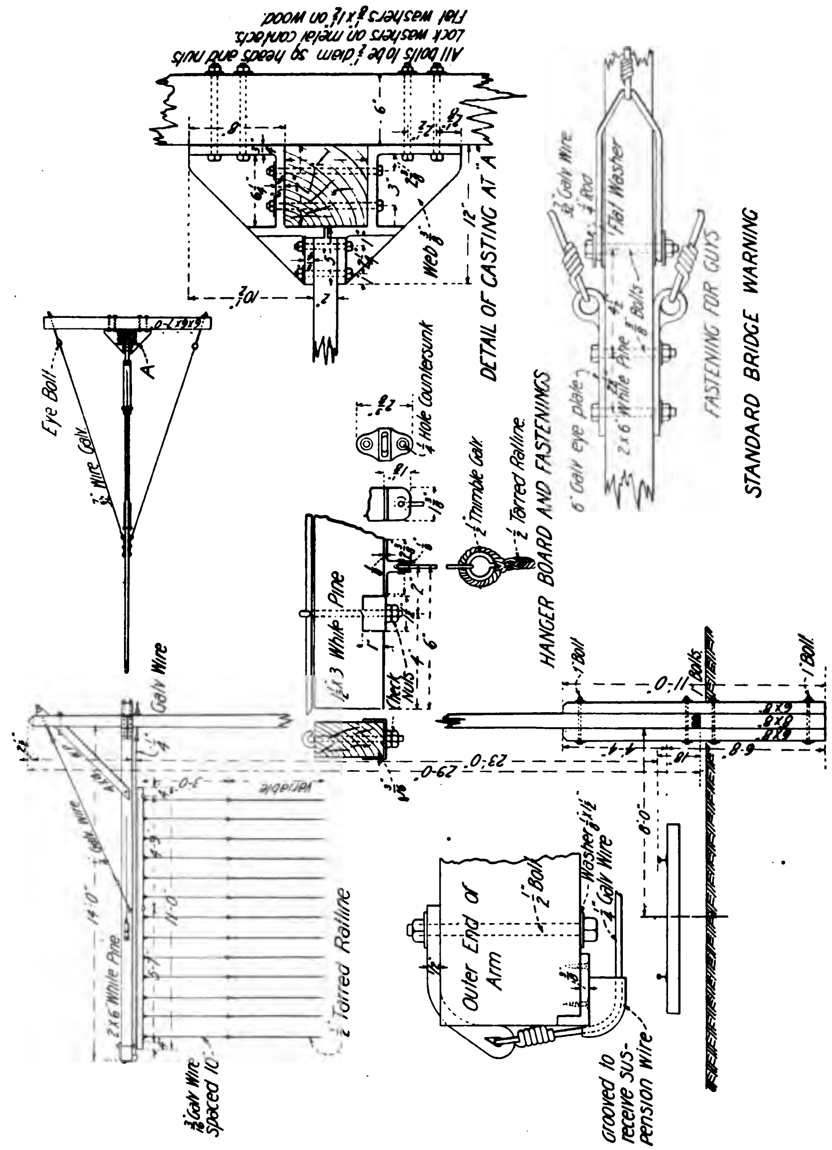
Standard Whip Guard for more than Two Tracks, Chicago & Northwestern Ry. (Note: Guy Wires not Necessary.)



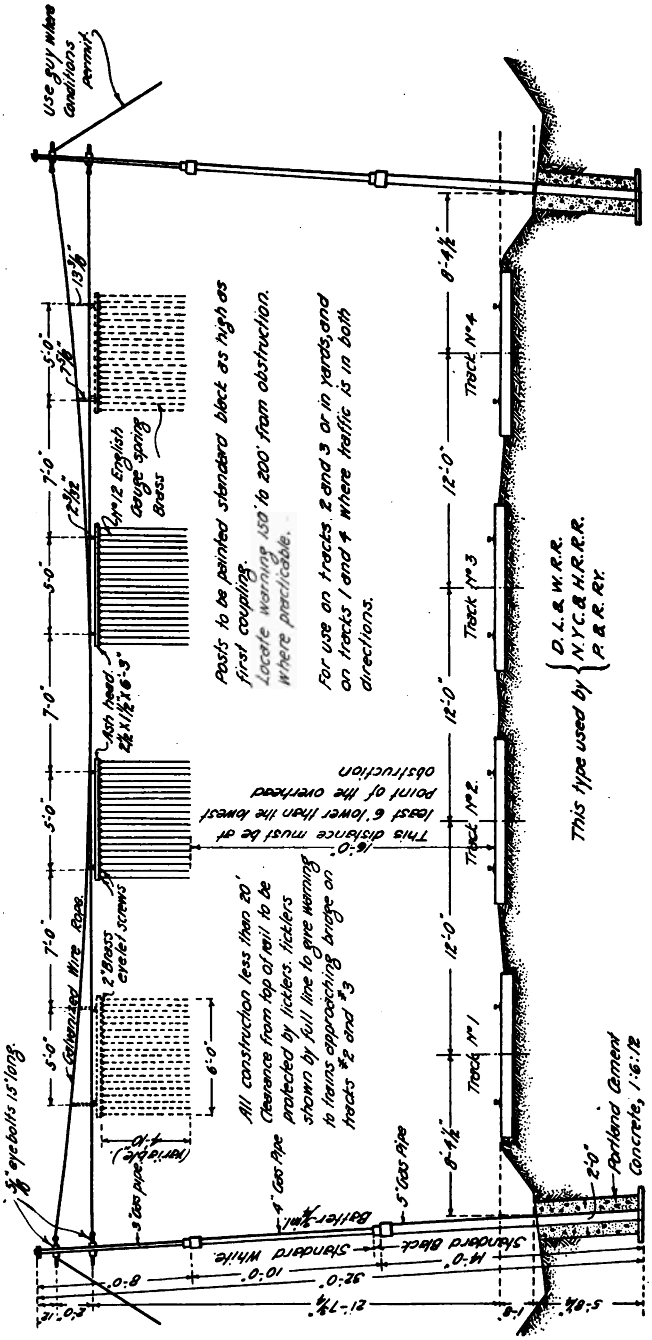
REDUCING "Y" JOINT.



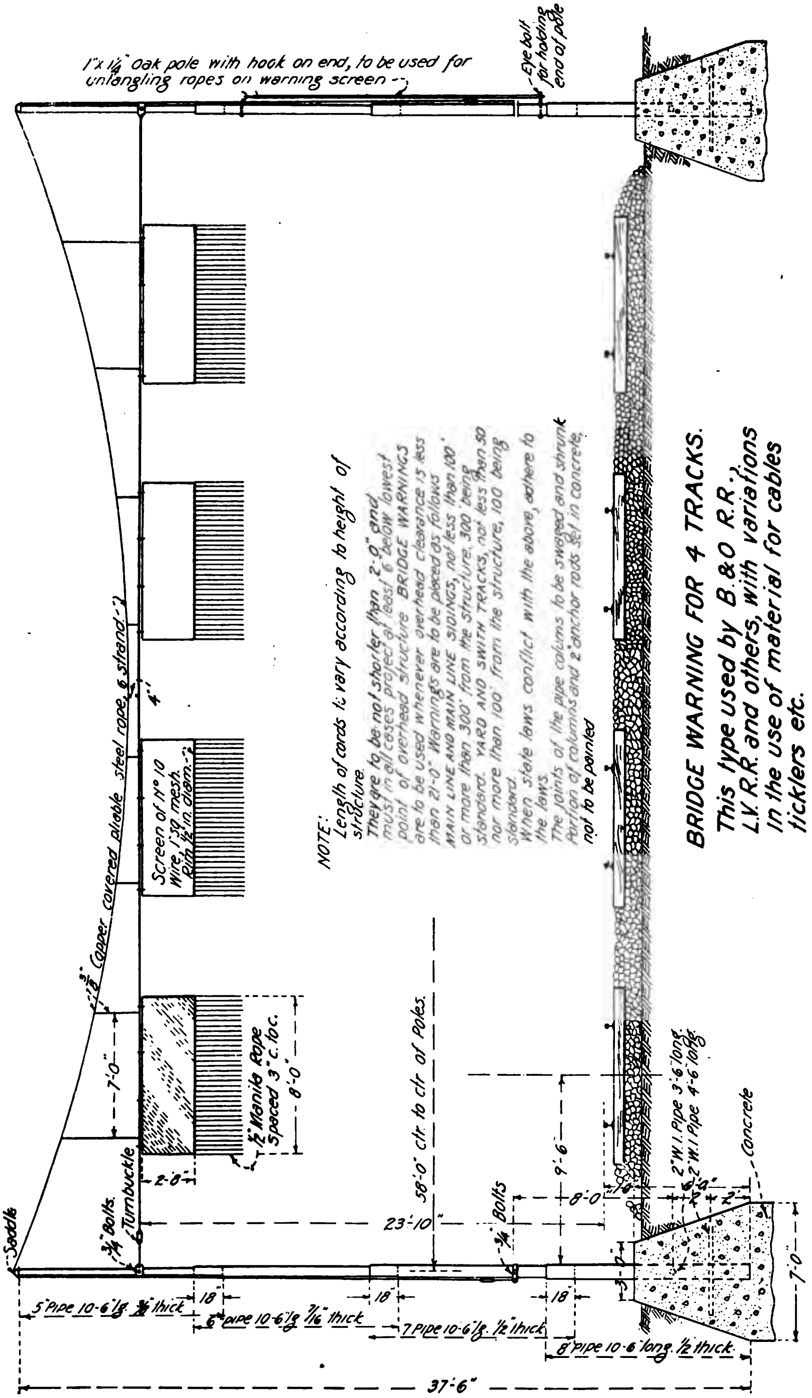
Standard Bridge Warning, Chicago Great Western R. R.



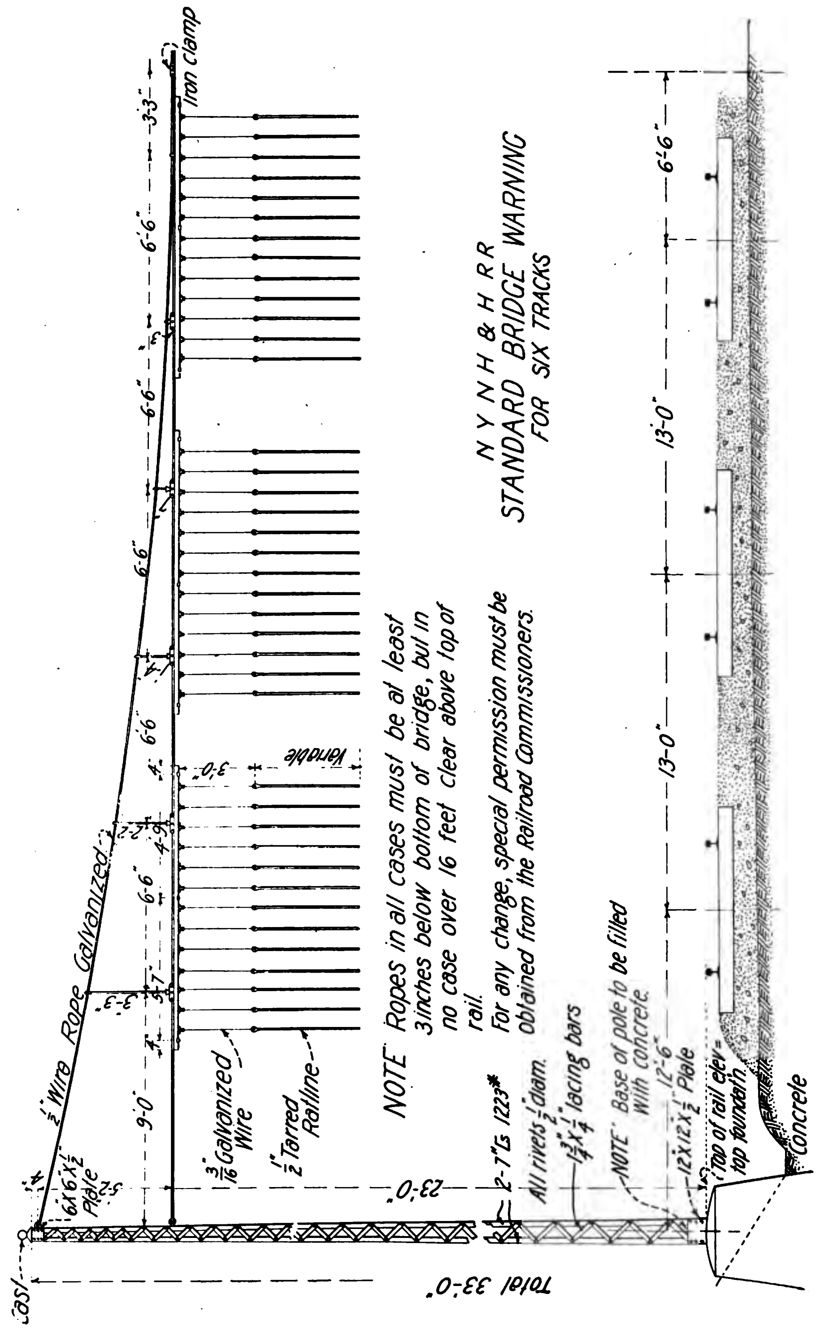
Standard Bridge Warning for Single and Double Track, New York, New Haven & Hartford R. R.



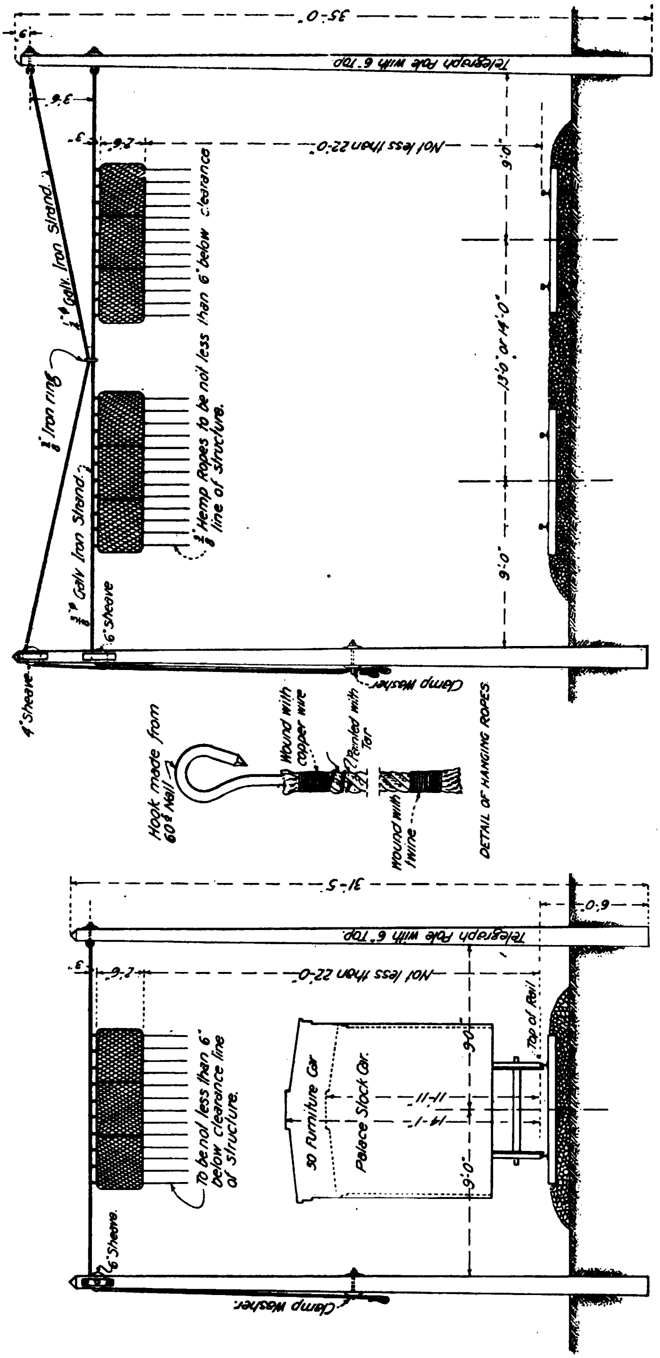
Standard Bridge Warning used by Several Roads.



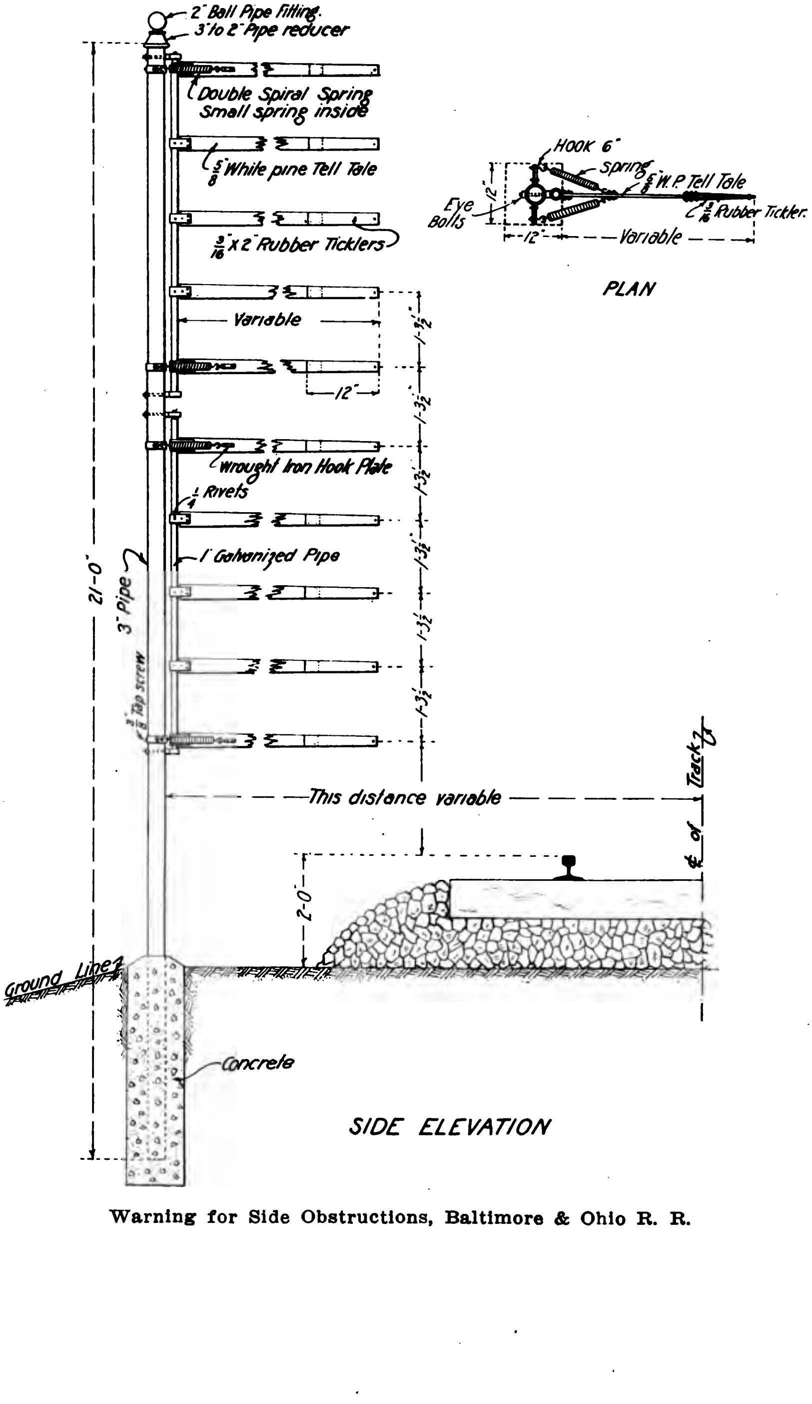
BRIDGE WARNING FOR 4 TRACKS.
This type used by B. & O. R.R., L.V. R.R. and others, with variations in the use of material for cables ticklers etc.



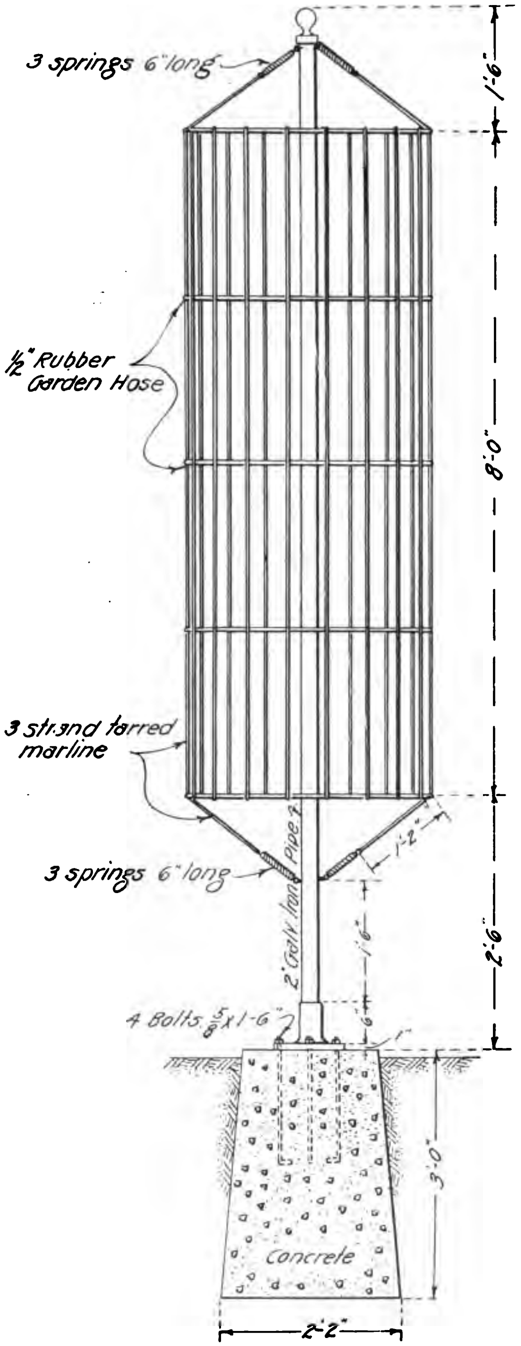
Standard Bridge Warning for Six Tracks, New York, New Haven & Hartford R. R.



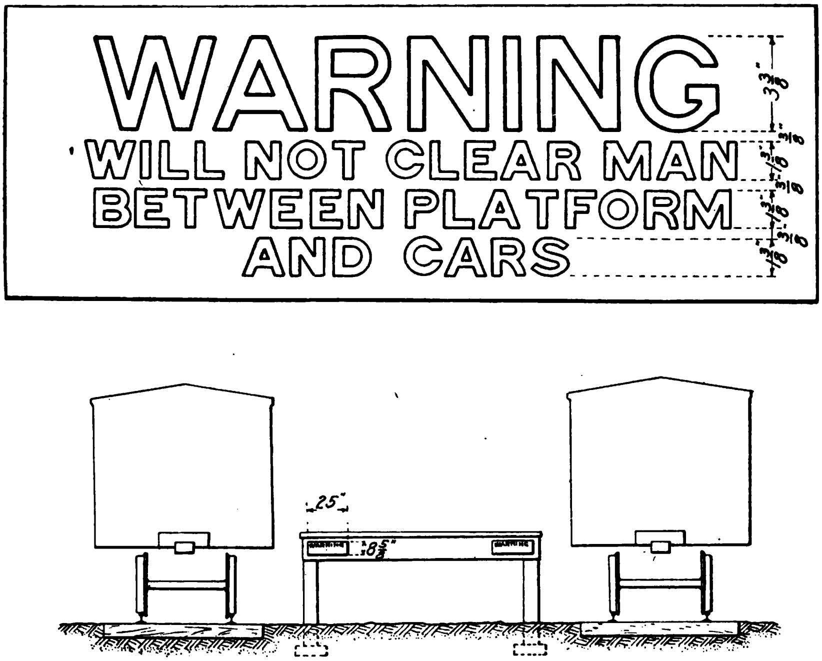
Standard Tell Tales, Chicago, Burlington & Quincy R. R.



Warning for Side Obstructions, Baltimore & Ohio R. R.



Vertical Tell Tale for small side Clearances, C. B. & Q. R. R.



Warning Sign for Freight Platforms, Chicago Great Western R. R.

DISCUSSION.

(Subject No. 2, Warnings for Overhead and Side Obstructions.)

F. E. Schall:—I want to call attention to the fact that the committee recommends that obstructions having a clearance of 21 ft. and over should not require warnings.

A. S. Markley:—The height is usually regulated by the railroad commission of each state. In Illinois, the limit for all overhead clearances is 22 ft. and anything under that must be provided with what we call ticklers or warnings. The ones we have adopted as standard have been in use for 8 or 10 years. They are similar to the design shown in the report as being used by the Pennsylvania Lines, and those in use by the New York, New Haven & Hartford. We experience considerable trouble with the ⅜ in. cords, the ends of which we wrap with copper wire. We have trouble with switchmen tying up the cords to keep them out of the way while they are giving signals, etc.

I would recommend that a man use a ladder when making repairs as it is dangerous to attempt to climb a pole without one. We make our poles of iron now. The cost of warnings constructed with wooden poles is $65 each.

F. A. Taylor:—I do not approve of turnbuckles being placed within reach of the public. We find that they are tampered with. They should be high enough to make it necessary to use a ladder to reach them.

G. W. Rear:—I would like to ask the consensus of opinion of this convention with reference to the placing of warnings for structures slightly under the limit allowed by the commission. Should ticklers be placed where there is a clearance of 21 ft. 11 in.? If so, who could touch them? A man 6 ft. tall on a 15 ft. car would reach but 21 ft. If no one could hit the obstruction, why would it be necessary to put ticklers up, even on a structure of less than the usual height? I don't think it is necessary to put ticklers on a structure that will clear everybody, although it may still be less than the legal height. I would also like to ask the experience of those having had to do with cable warnings over 3 or 4 tracks. What happens when a strong wind strikes them?

F. A. Taylor:—We have warnings on 3, 4 and 5 tracks and have had no loss through storms. We use copper or steel cables, and when well braced they never blow down.

A. S. Markley:—Answering Mr. Rear's question: of course, if a man should be injured, on a structure with less than 22 ft. clearance the railroad company would be held liable on account of having taken no precaution to protect him. I realize that no car is 15 ft. high, unless piled with lumber.

G. W. Rear:—The railroad is liable in this state in any case, whether it takes precautions or not. However, it does not look as though we ought to take the precaution to protect anything or anyone from an obstruction they can not hit. It would seem as though we ought to recommend that ticklers be put on structures with a clearance of 21 ft. or less; and that when cars become large enough so that a man can hit an obstruction at 21 ft. we should put up ticklers where clearances are between 21 and 22 ft.

A. A. Wolf:—In reference to one of Mr. Rear's inquiries: the height in the state of Wisconsin is not regulated by the railway commission or by state law. We are simply required

to furnish protection or signals at all obstructions less than 7 ft. above the top of a car; it is left to us to determine the limit and we have adopted a height of 22 ft. to be on the safe side.

As to signals blowing down, we have one carrying 17 sets of ticklers on one head-wire which has never given any trouble since it was erected 4 years ago.

A. S. Markley:—In Illinois, and particularly in incorporated villages, or in towns where there is no possibility of securing the specified clearances, the railroads are exempt from maintaining such clearances. In Indiana, we are required to maintain a side clearance of 18 in. Our standard clearance on the main track is 10 ft., and on side tracks 8 ft., from the center of track.

G. Aldrich:—We use a tarred rope tickler, ½ in. in diameter, which lasts much longer and stands the weather better than the regular manila rope. I think that Russian ratline is better than either but we can not get our people to buy it.

The President:—Mr. Taylor, of the B. & O., made a very just criticism of the report. I would like to refer to the committee the subject of the turnbuckle being located within reach of the public and mischievous boys.

E. G. Storck:—I think the height of turnbuckle should be as we have it on our road,—low enough to enable a man to reach it from the ground, thus obviating the necessity of carrying a ladder. On our road, it is necessary to send a gang every two weeks to repair the different warnings and tighten the lines. It is much more convenient to have the turnbuckle within reach, as it is necessary to use a bar, and it is difficult to use a ladder especially where two tracks are spanned. This is our reason for stating the turnbuckle should be within reach from the ground.

F. E. Schall:—It seems to me that it would be a very simple matter to place a sheet-iron casing over the turnbuckle and have it within reach of the ground, rather than make it necessary to use a ladder.

C. W. Richey:—We have hundreds of warnings in use, and to my knowledge, we have never experienced any trouble on account of their being tampered with. It is very convenient to adjust them from the ground.

We have no standard for side clearance, but are considering the adoption of one, and I would like to have a suggestion as to the proper method to pursue. I should think that when going at sufficient speed, a man struck by a warning would be hurt about

as badly as if struck by the obstruction itself. We are considering the adoption of posts somewhat similar to the ones shown in the report. Instead of using springs, however, we would use rattan, allowing it to project about 6 in. along the obstruction with 2 in. centers. This is going to be a big problem, on account of the tunnels and warehouses.

A. S. Markley:—The side clearance question is one with which we have had some difficulty. On the low-speed tracks in our terminals, we tried rattan, and before it was up a month it was out of line. We tried to maintain it in proper position, but soon ran out of rattan. We finally put on ticklers, the same as on ordinary clearances.

E. G. Storck:—We sent out 50 letters on the subject of side clearance, and received replies from only two having any standards and these are shown in the report. Evidently, not much attention is paid to side clearances. It seems to me that the type used by the Baltimore & Ohio is as neat and cheap an arrangement as can be gotten up. I consider this an important phase of the subject and would like to hear further discussion.

J. S. Robinson:—A short time ago we had a case where side clearance was necessary on account of a fraternal society establishing a school near one of our through bridges where the side clearance was quite narrow. We tried a device but I received notice that a Californian had a patent on something similar, hence we abandoned the scheme, which consisted of No. 6 or No. 9 wires projecting from a vertical post and having the tips of the wires protected with rubber or cork. After being notified of the patent on this scheme we substituted a wooden post upon which were fastened some wooden strips, and this seems to answer the purpose fairly well. There should be some effective devices on the market.

Mr. Warcup:—On the Grand Trunk the clearance, for side obstructions, is 6 ft. from the rail. In Canada it is 8 ft. 6 in. from the center of the track or 6 ft. from the rail.

Mr. Rear:—Is that clearance observed on bridges?

Mr. Warcup:—Yes, that is the law at the present time.

Mr. Richey:—Possibly some of the members have had actual experience with warnings for side clearances. If so, this is your opportunity to express your opinion as to the proper device. We might devise something of merit. You might put up a sign to be seen in daylight, but of no protection, whatever, at night.

The Pennsylvania State Railway Commission has adopted clearance standards. We had a number of old obstructions before the specifications were adopted and the specifications apply only to buildings or obstructions erected since they went into effect. I do not recall the required side clearance now.

Mr. D. B. Taylor:—The commissioners went over the road with us, and made us move back everything that was not 7 ft. from the center of the track in Indiana. The coal trestles were only about 5 ft. 6 in. from the center of the track.

Mr. A. S. Markley:—Seven ft. centers? That would make only 4½ ft. clearance. That is bridge clearance, and I am quite sure that a member of the commission in Indiana would require 18 in. beyond the widest cab, which is 10 ft. 4 in. wide.

Mr. Richey:—In regard to the position of the turnbuckle: a locking device might offer a solution.

A. H. Beard:—It is a question in my mind whether the locking device would serve as a preventative if anybody wants to tamper with the turnbuckle. I do not like the lock nut idea.

Side clearance standards impress me as being a good thing. I do not agree with the gentleman from Pennsylvania. I think it would be well to have the committee continued, to give us a little more information. Side clearance is a very important feature. There have been more people injured on account of side clearances than in any other way. At least such is the case in my district.

J. A. Given:—When the tracks of the Southern Pacific limit side clearances, we revise the floor of the car. In other words, where the platform is car floor height, or not, we build it 7 ft. 3 in. from the center of track. Anything higher, is 8 ft. 6 in. from the center of track. That applies to all of our own buildings.

A. H. King:—Referring to the question regarding the position of the turnbuckle: I think the one shown in the drawing illustrating the standard overhead tell-tale of the C. B. & Q. is about right. While the distance is not given, I judge from the scale that it must be about half way from the top, and would require a step ladder to reach it. This would keep people from tampering with it, and at the same time it would not be so high as to make it dangerous for anyone to adjust it. If the turnbuckle was located at the top, it would not be a "safety first" proposition. A long lad-

der would be required, and there would be nothing stable to rest it against.

The Union Pacific uses a screen to prevent the ticklers from going over the top and to keep them in proper position. This is a very good plan. Where screens are used the clearance should be 22 ft. or 23 ft., as they might injure a person if struck by them.

C. W. Richey:—I would suggest that the committee be continued until next year; paying particular attention to side clearances. I would be glad to serve on the committee.

A. S. Markley:—I believe the committee, if continued, should secure copies of the laws of different states. This would give all the information the state railway commissions have on clearances. At least that is the case in Indiana and Illinois.

SUBJECT NO. 4.

REINFORCED CONCRETE BRIDGES.

REPORT OF COMMITTEE.

In taking up the work on reinforced concrete structures, the committee decided that a canvass should be made of the railroads of the United States and Canada, to determine to what extent reinforced concrete is in use for bridges, the types developed and in most general use, and the practice of different railroads regarding standard types and specifications for design.

A form was made up, showing the data desired, and arranged for convenient entry. Prints of this form were sent out to the proper officials of about 100 railroads, with requests that they fill it out or submit data and information in the shape of plans, specifications, etc. The following table is a summary of the reports received from the roads that responded:

General.

It will be noted from the above summary that there are no reinforced concrete structures on a large proportion of the mileage reported. It is very likely that if full information could be had, it would be found that the proportion of roads on which reinforced concrete is not in use would be greater than shown in this report, as some of the roads failed to send in reports because they had no structures of this kind. This was brought out in a few personal interviews, and it is quite possible that this was the reason in other cases why roads failed to report.

The two types of structures most in favor are the box culvert and the deck slab. On two large systems the deck slab is the only type of reinforced structure in use. Following these are the retaining wall and the trestle. These four leading types are far ahead of any of the others, in the number of roads on which they are used, and in the mileage of those roads. If measured by the total aggregate of structures their lead over the other types would probably be even greater. The C. M. & St. P. Ry., alone, has approximately 7 miles (estimated on single track basis) of the deck slab shown in Fig. 6.

There is considerable diversity among the various railroads in the specifications, design and details of practically every type in use. On only a few points is there anything like uniformity. A 1:2:4 mixture and a moduli ratio of 15 appears to be quite generally accepted as correct for fully reinforced structures.

Fig. 2, the tabulated data on deck slabs, are typical of the specifications on various roads.

The types shown in Figs. 3 to 14, inclusive, have been selected to bring out distinctive features in design and detail of types in use on different roads. Figs. 3 and 4 are plans of box culverts of the Union Pacific and C. & N. W. Ry. types respectively. In the Union Pacific type the reinforcement consists largely of bent bars; the wings are reinforced and connected by their reinforcement to the footings and to walls of the culvert. The paving extends to the ends of the wings, and

this places the end walls at the ends of the wings. The corners at the bottom are filleted the same as the top, and the footing does not project beyond the walls of the culvert. In all of these features the C. & N. W. type is different. Figs. 5 and 6 are the plans of deck slabs of the D. M. & N. R. R., and the C. M. & St. P. Ry., respectively. There is a considerable difference in the details of concrete and the arrangement of reinforcement in these two designs of the same type of structure.

For the design of slab tops for culverts, compare Fig. 7 of P. R. R. (Lines West); Fig. 8, E. P. & S. W. Ry., and Fig. 11, C. M. & St. P. Ry. The distinctive features of the P. R. R. slab (Fig. 7) is the separation into track slabs and side slabs. The E. P. & S. W. plan (Fig. 8) shows a unique method of carrying the track on pedestals while the slab is being built. The arrangement of reinforcement is different in all three designs.

Fig. 9, plan of arch culvert and form, of the C. M. & St. P. Ry. contains a number of distinctive features in design and in forms, which are readily recognized in the plan.

Figs. 10 and 11, plan of trestle, show the design and detail of a type of structure much in use on the C. M. & St. P. Ry.

Figs. 12 and 13 are the plans of special retaining wall of the N. Y. N. H. & H. R. R., and illustrate the design of high retaining wall with counterforts, with and without piles under footings; also section of low retaining wall without counterforts. These plans are to be compared with Fig. 14, plan of typical retaining wall with uniform section, as built by the C. B. & Q. R. R. in much of its track elevation work in Chicago.

Reinforcement Material.

Three types of reinforcing bars are in quite general use—(1) Plain round bars; (2) Square bars, straight and twisted; and (3) Deformed bars. Many roads use all three types, the square and the deformed bars being generally preferred to the plain round bars. Unit systems of reinforcement appear to be very little used for railroad bridge work, as none of the reports showed this type in use for bridge construction.

There are marked differences in the arrangement of the bars in the structures on different roads. This is apparently due more to methods of construction than design. Some roads use only straight bars, or bars simply with short bends at the ends, while others do not hesitate to use bars with four to six bends.

It is quite generally accepted that bent bars, if made true to form, and properly placed in the structure, will fulfill the requirements of design better than a combination of straight bars. They eliminate the sharp turns in the direction of reinforcement, and give a continuity of reinforcement that is not obtainable with straight bars. An advantage in construction from using bent bars is the smaller number of bars to be handled and placed, a single bent bar being made to do duty for several straight ones.

There are, however, other considerations than design that enter into the selection of reinforcement; such as methods of handling, shipping and placing bars; facilities for bending bars in the field; skill and training of the men on the work. Manifestly a road with a good organization of well trained foremen and workmen, and ample facilities for bending and handling bars, would be less restricted in the type of reinforcement than a road dependent on contractors, or with a less effective organization of its own. The use of different forms of reinforcement applied to the same types of structures is illustrated in the plans of rectangular box culverts, Figs. 3 and 4 and deck slabs, Figs. 5 and 6.

All roads except one specify billet stock for reinforcing material.

Some go so far as to state specifically that re-rolled steel will not be accepted. The one road which now includes re-rolled deformed bars in its specifications reports that none have ever been used because they have never yet been available.

There is found considerable variation in the allowable working stresses of both steel and concrete. A certain amount of variation would be expected, due to differences in the material used in the concrete, and to the impact allowances in the load; but the wide range of working stresses cannot be fully accounted for by those differences. They must be attributed, in part, to the confidence, or lack of confidence that designing engineers have in the strength of the material and in their ability to analyze the conditions of the structure under load. It is not to be expected that the working stresses for reinforced concrete can be brought even near the uniformity that obtains in the working stresses specified for steel structures. There are too many uncertainties in both analysis and construction, and these can best be covered by a liberal excess of strength in the design. Designers will have more confidence in their analyses when they have been verified by the results of exhaustive tests. Such tests can best be carried on at the engineering experiment stations of the universities. To be conclusive, they should be comprehensive and exact enough to eliminate the possibility of abnormal results, and they should be conducted under conditions that approximate actual working conditions as nearly as practicable.

The tests conducted by Mr. Abrams at the Engineering Experiment Station of the University of Illinois, and published in Bulletin No. 71 of this station have added a great deal to our information on the strength of the bond between concrete and steel. In this series of tests, the plain round bars made a very creditable record. The bond resistance per unit of surface for square twisted bars was only 88 per cent of that developed by plain round bars. If the cross section of the bar be made the basis of comparison, it will be found that the square twisted bars developed practically the same bond resistance as round bars of equivalent section. In the light of these tests, Mr. Abrams concludes that "the results found with the twisted square bar does not justify its present popularity as a reinforcing material." These tests also proved that under ordinary laboratory conditions the deformed bar is no more efficient in developing bond resistance than the plain round bar. It was not until the conditions of initial failure were produced that the deformed bar developed bond resistance higher than the plain round bars.

It is evident from the records of these tests that the value of plain round bars as reinforcing material may have been underestimated and also, that twisted and deformed bars may have been credited with much merit which they do not possess, or which does not become effective under practical working conditions. However, the fact should not be overlooked, that vibration, which is so large an element in working conditions, could not enter into the results of the laboratory tests. Designing engineers may feel that the deformed bar offers a security against vibration, and against initial failure, that fully justifies its use in spite of the excellent showing made by the plain round bar in the laboratory tests. However, since the claims for superiority of twisted and deformed bars over plain bars are based on their capacity for developing greater bond resistance, it would not be amiss for designing engineers to review their specifications in the light of these tests, with a view to making such revisions in the working bond stresses of the different types of bars as may be justified.

The committee wishes to advise the association that much valuable data and information received in the reports from railroads came to

hand too late to be available for this report. It would recommend, therefore, that the association continue the committee on Reinforced Concrete Bridges, with instructions to present its final report at the convention in October, 1915.

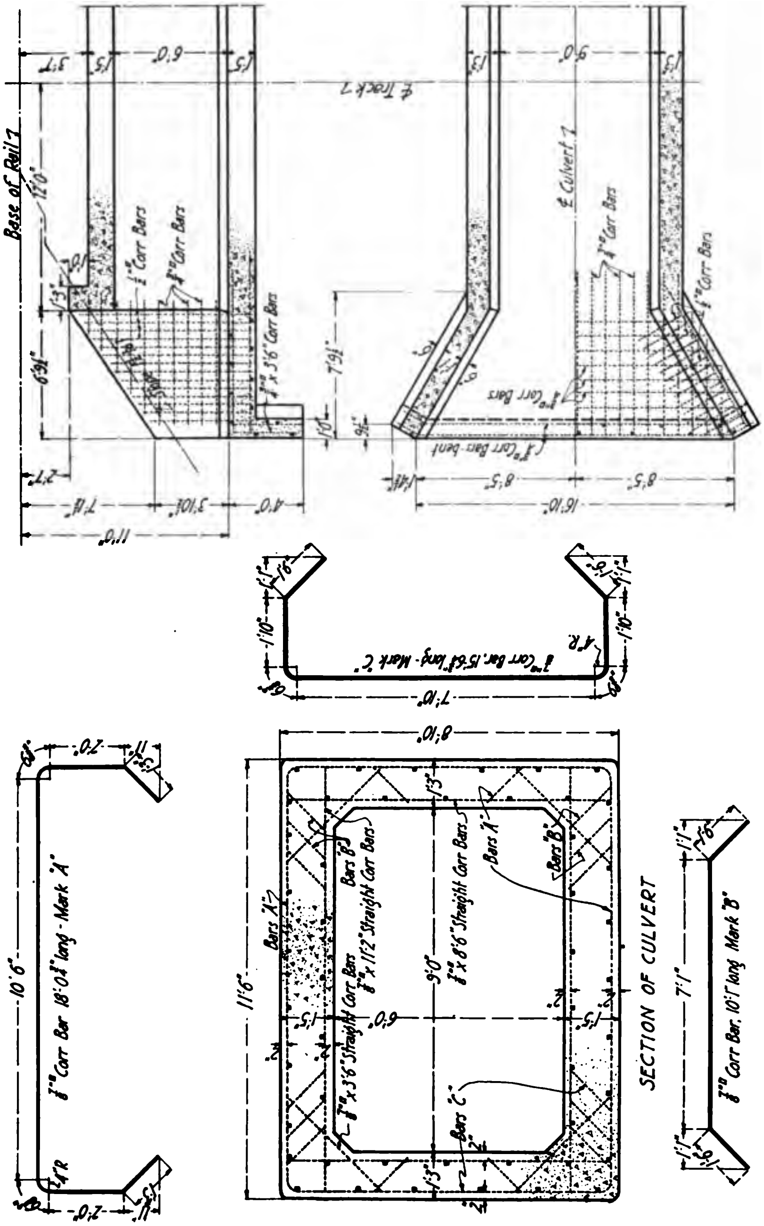
O. F. Dalstrom, Chairman.
I. L. Simmons,
L. D. Hadwen,
J. A. Bohland,
A. Montzheimer,
C. J. Scribner,
D. C. Zook,
Committee.

	TYPES OF REINFORCED CONCRETE STRUCTURES IN USE									
	ARCHES BARREL TYPE	CULVERTS (RECT. BOX TYPE)	CULVERTS (ARCH TYPE)	ABUTMENTS SOLID	ABUTMENTS (HOLLOW OR ARCH)	PIERS	TRESTLES	DECK SLABS	RETAINING WALLS	CITY SUBWAYS
Number of Roads on which type is reported in use.	16	30	15	18	13	15	17	28	23	15
Mileage of Roads on which type is reported in use.	61270	106972	48559	67580	52992	55932	76808	104776	81120	10864
Total number of Roads reported										54
Total mileage of Roads reported										163 449
Number of Roads reporting no reinforced concrete structures										13
Mileage of Roads reporting no reinforced concrete structures										24664

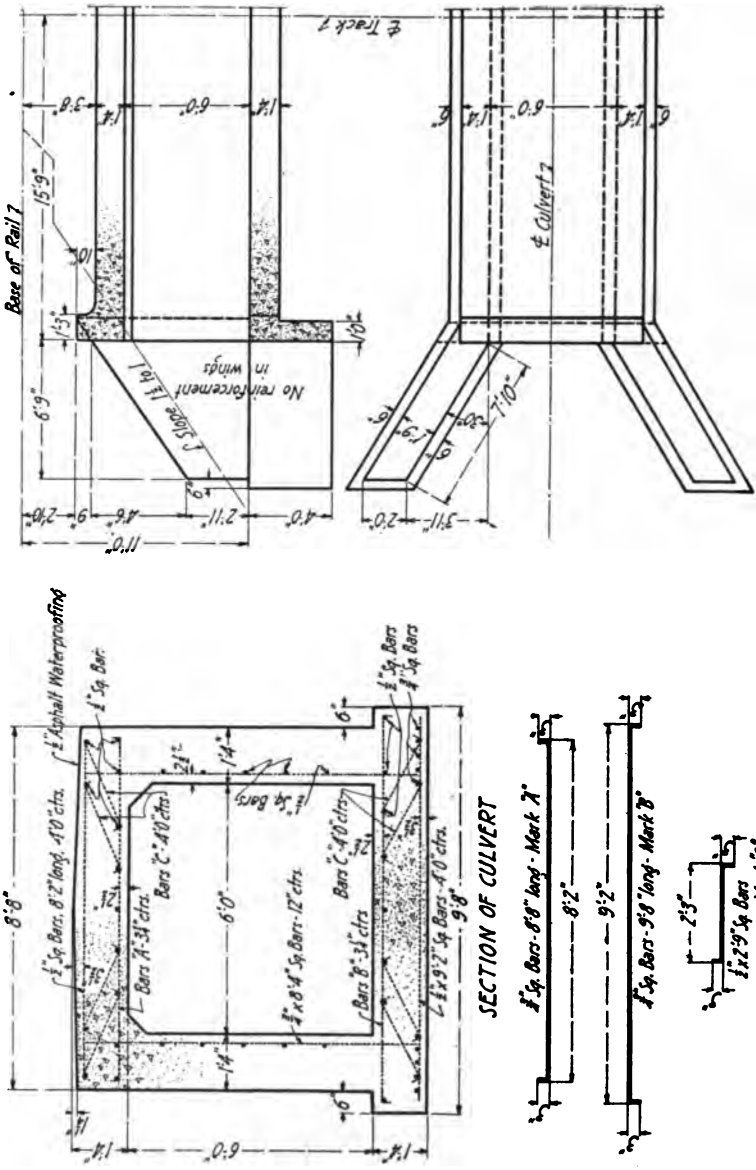
FIG. 1.

DECK SLABS										
1	2	3	4	5	6	7	8	9	10	11
RAILROAD	PROPORTIONS OF INGREDIENTS IN EACH PART OF STRUCTURE	CHARACTER OF AGGREGATE	REIN-FORCING BAR	MAXIMUM ALLOWABLE STRESS POUNDS PER SQUARE INCH: TENSION IN STEEL Fs	COMPRESSION IN CONCRETE Fc	SHEAR IN CONCRETE S	ADHESION OF STEEL AND CONCRETE A	RATIO OF MODULI OF ELASTICITY OF STEEL & CONC. FOR WORKING STRESSES	LIVE LOAD EQUIVALENT TO COOPERS CLASS E	IMPACT
A.C.L.	1:2:4	WASHED GRAVEL 3/4" MAXIMUM DIAMETER	DEFORMED BILLET STOCK	16000	600	30	100 175	15	E-60	$\frac{L^2}{L+D}$
B. & M.	ALL REINFORCED CONCRETE STRUCTURES IN ACCORD WITH A.R.E.A. SPECIFICATIONS									
A.T. & S.F.	1:2:4		DEFORMED BILLET STOCK	15000	700	30	150	15	E-70	
B. & O.	1:2:4	CRUSHED STONE	PLAIN OR DEFORMED	16000	600	60	50	15	E-50	50% OF L.L.
CENT. OF GA.	1:2:4	CRUSHED STONE OR GRAVEL	TWISTED OR DEFORMED BILLET STOCK	16000	650	120	150	15	E-55	100% OF L.L.
C.B. & Q.	1-CEMENT TO 4-GRAVEL	GRAVEL CONSISTS OF 1 PART FINE & 2 PARTS COARSE MATERIAL-WELL MIXED	DEFORMED BILLET STOCK	18000	800	200	200	15	E-56 OR OVER	50% OF L.L.
C.G.W.	1:2:4	CRUSHED STONE OR GRAVEL-GRADED SIZES-1/4" MIN. DIAM.	DEFORMED	17000	750	120	100 150	15	E-55	50% OF L.L.
C.M. & St.P.	1:2:4	CRUSHED STONE OR CRUSHED GRAVEL-2" MAX.	DEFORMED OR TWISTED BILLET STOCK OR REROLLED	16000	700 FOR EXTREME FIBRE IN BENDING	90	PLAIN BARS 50 DEFORMED 100		E-55 & E-60	$\frac{8}{10}\times\frac{L^2}{L+D}$
C.C.C. & St.L.	1:2:4	CRUSHED LIMESTONE	DEFORMED BILLET STOCK	16000	700	50	PLAIN BARS-50 DEFORMED BARS 120	15	E-60	$S\left[\frac{300}{L+300}\right]$
C. & N.W.	1:2:4	CRUSHED STONE 1" MAX. DIAM.	SQ. TWISTED OR DEFORMED BILLET STOCK	12000	660			15	E-55	90% OF L.L.
C.R.I. & P.	1:2:4	CRUSHED STONE GRAVEL	PLAIN AND DEFORMED BILLET STOCK	15000	650	30		15	E-55	50% OF L.L.
L. & N.	1:2:4	BROKEN STONE OR GRAVEL	TWISTED BILLET STOCK	RECOMMENDATIONS OF JOINT COMMITTEE				15		90% OF L.L.
E.J. & E.	1:2:4	WASHED GRAVEL	SQ. TWISTED BILLET STOCK	16000	650	40	100	15	E-60	50% OF L.L.
ILL. CENT.	1:2:4	CRUSHED STONE OR GRAVEL	DEFORMED OR PLAIN BILLET STOCK	17000	750	40	PLAIN BARS-80 DEFORMED BARS 120	15	E-55	$\frac{1}{2}\times\frac{L^2}{L+D}$
K.C. SOUTH.	1:2:4	CRUSHED STONE OR WASHED GRAVEL	CORRUGATED, TWISTED OR PLAIN BILLET STOCK	15000	600	35 TO 100 DEPENDING ON KIND OF REINFORC'MT.	PLAIN-65 TWISTED-110 CORR.-150	15	E-60	40% OF L.L.
LEHIGH VAL.	1:2:4	CRUSHED STONE OR WASHED AND SCREENED GRAVEL	PLAIN AND TWISTED BILLET STOCK	16000	650	30	PLAIN-60 TWISTED-100	15	E-60	$\frac{L^2}{L+D}$
M. & St.L.	1:2:4 BOTTOM 2" OF SLAB, BELOW STEEL TO BE 1:2 MORTAR	GRAVEL	DEFORMED BILLET STOCK	18000	650	75			E-55	$S\left[\frac{300}{L+300}\right]$
Mo. Pac. Syst.	1:2:4	CRUSHED ROCK OR GRAVEL	DEFORMED BILLET STOCK	16000	650	120 WITH WEB REINFORC'MT.	150	15	E-50	$S\left[\frac{300}{L+300}\right]$
N.C. & St.L.	1:2:4	CRUSHED STONE (PREFERRED) AND GRAVEL	PLAIN OR TWISTED	16000	750	40	80	15	E-50	$S\left[\frac{300}{L+300}\right]$
N.Y.N.H. & H.	1:2:4	CRUSHED TRAP ROCK OR LIMESTONE 2" MAX. DIAM.	SQUARE TWISTED BILLET STOCK	14000	650	40	80	15	1200# PER □'	100% OF L.L.
N.Y.O. & W.	1:2:4	CRUSHED LIMESTONE	DEFORMED BILLET STOCK	16000	650	40	50	15	E-50	100% OF L.L.
PENN. (EAST)	1:2:4	3/4" GRAVEL OR 3/4" CRUSHED STONE	PLAIN TWISTED BARS BILLET STOCK	12000	600	50	100	15	E-55 (ABOUT)	PER RR. CO'S SPECIFICATIONS
PENN. (WEST)	1:2:4	CRUSHED STONE PREFERRED	SQ. TWISTED OR PLAIN (TWISTED PREFERRED)	$\frac{15625}{2-\theta}$ $\theta=\frac{\text{D.L. MOM.}}{\text{TOTAL MOM.}}$	$\frac{625}{2-\theta}$	50	BARS DEVELOPED, PLAIN IN 60 DIA., TW'D IN 25 DIA.	15	MAX. AXLE LOAD IN SERVICE OR 60,000	NONE
N.Y.C. & H.R.	1:2:4	BROKEN STONE OR GRAVEL	TWISTED OR DEFORMED BILLET STOCK	14000	650	30	PLAIN-60 DEF'MD-150	15	E-60	$S\left[\frac{300}{L+300}\right]$
SOUTHERN	1:2:4	CRUSHED STONE	PLAIN ROUND BILLET STOCK	16000	650	40-PLAIN 120-REINF.	80	15	E-55	50% OF L.L.
W. & L.E.	1:2:4	CRUSHED STONE OR SLAG	TWISTED OR CORRUGATED	16000	650	120	80	15	AXLE LOAD DIS. OVER 9'0"x5'0"	90% OF L.L.

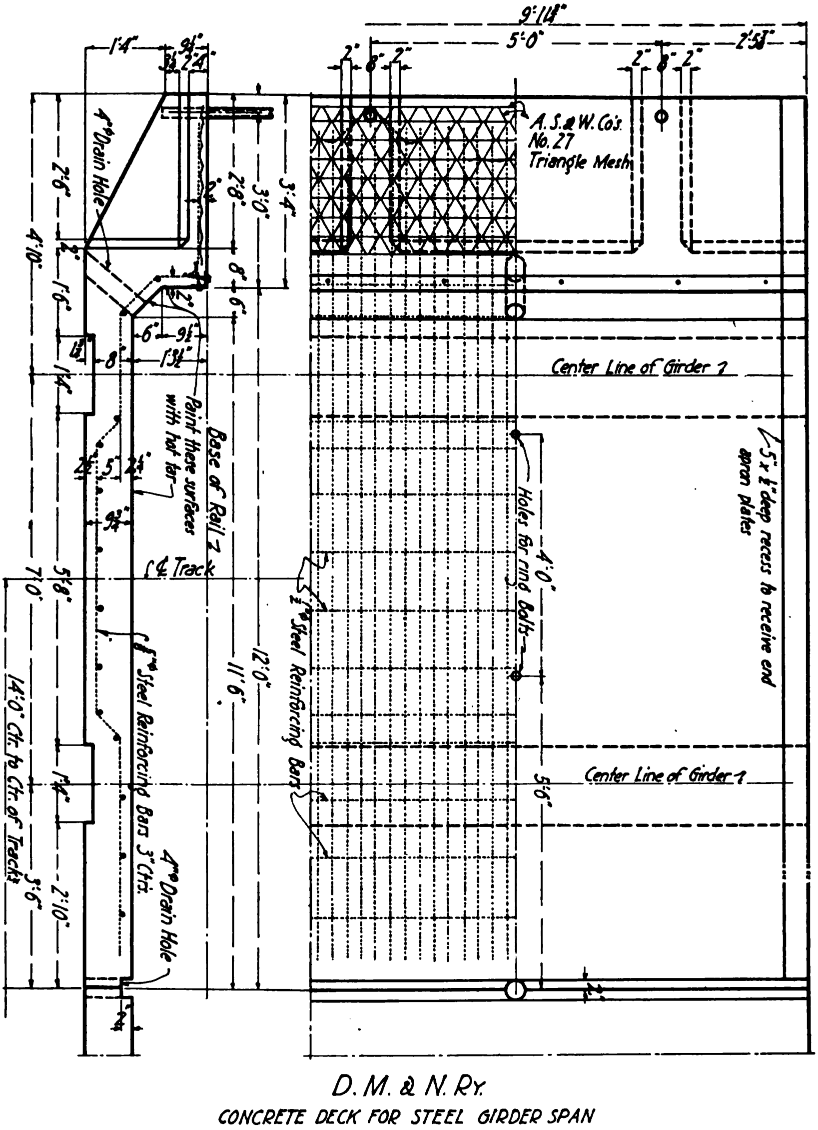
FIG. 2.



9'x6' BOX CULVERT - UNION PACIFIC R.R.
FIG. 3



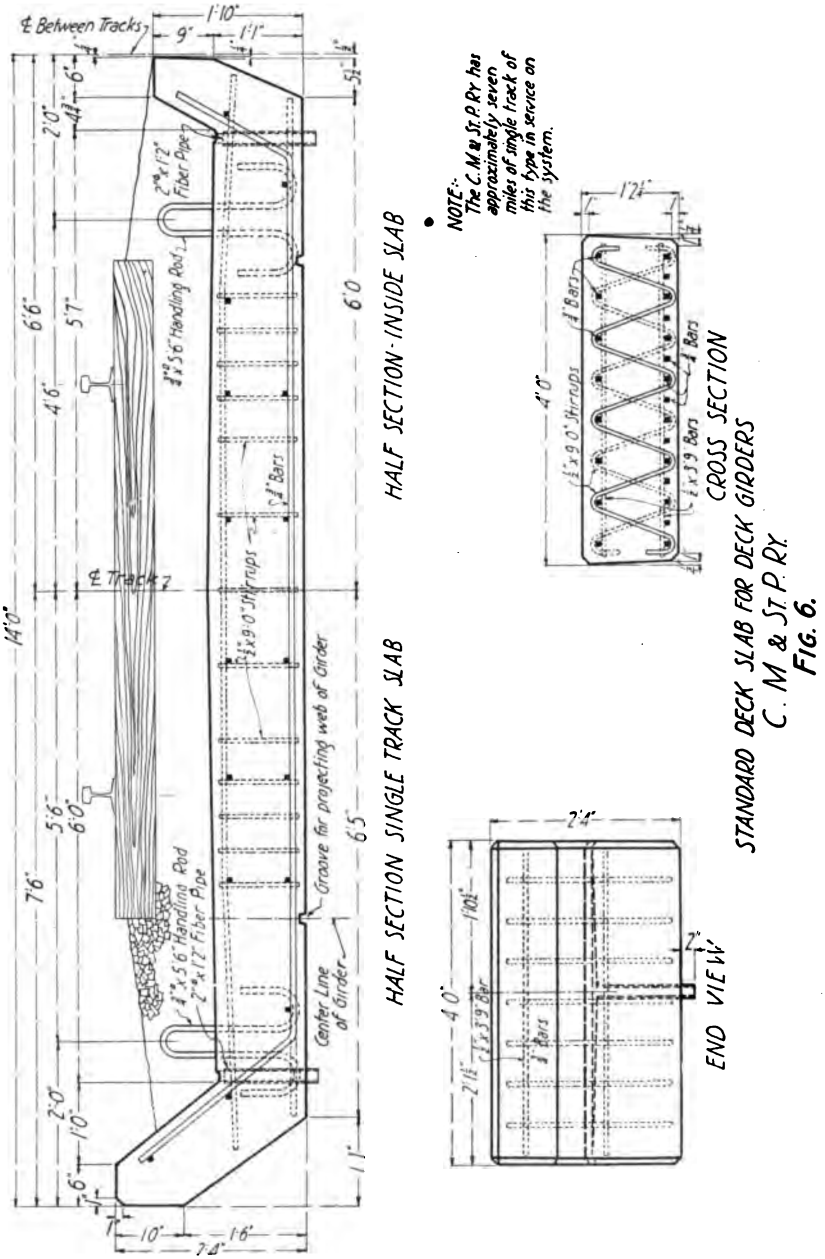
STANDARD 6'x 6' BOX CULVERT · C.& N.W.RY.
FIG. 4.



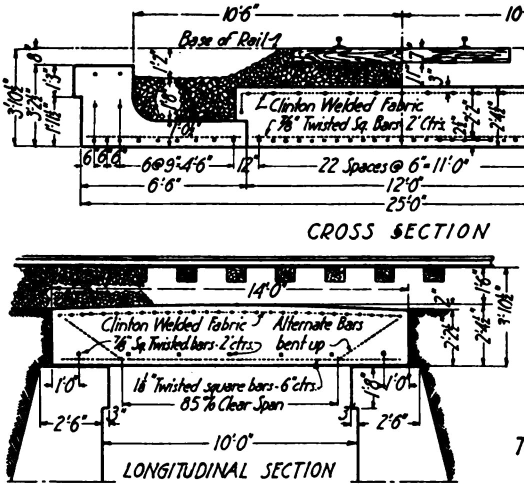
D. M. & N. Ry.

CONCRETE DECK FOR STEEL GIRDER SPAN

FIG. 5.

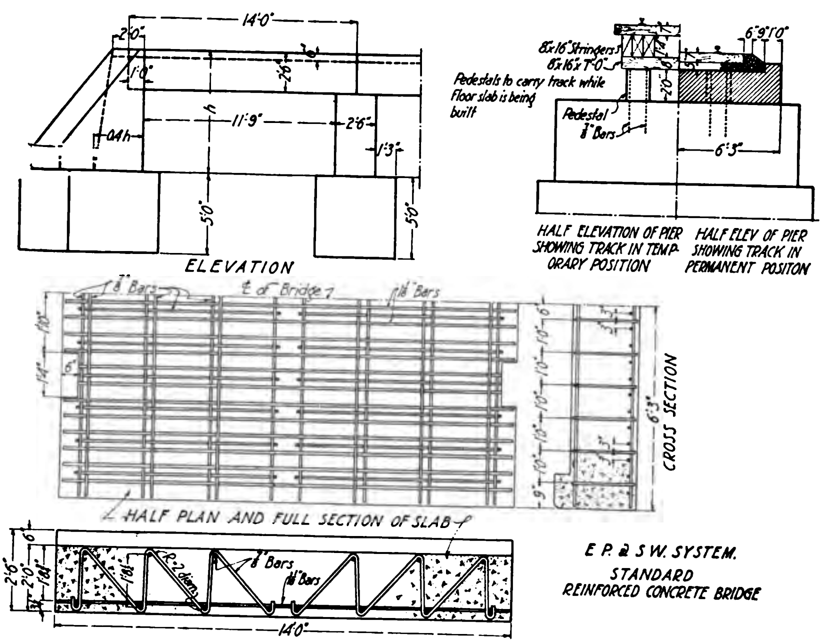


STANDARD DECK SLAB FOR DECK GIRDERS
C. M. & St. P. Ry.
Fig. 6.



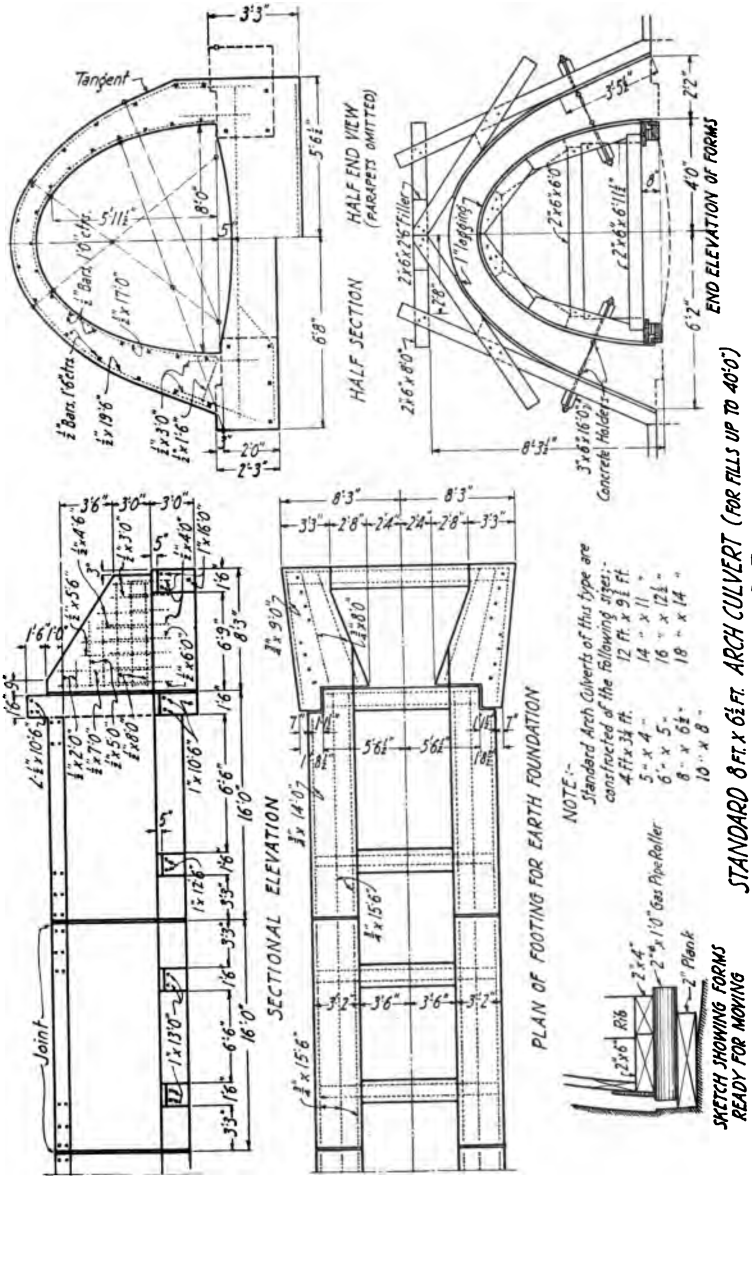
PENNSYLVANIA R.R.
LINES WEST OF PITTSBURGH
TYPICAL REINFORCED CONCRETE SLAB

FIG. 7

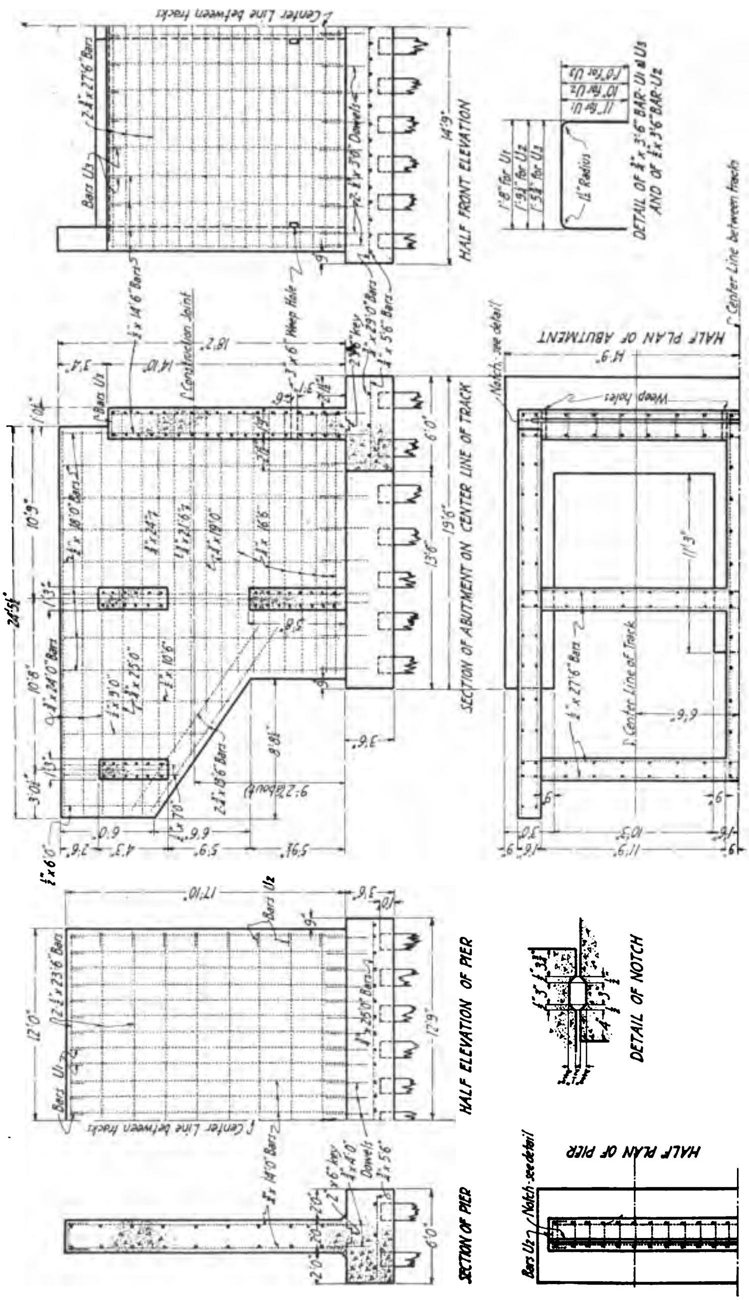


E P. & S W. SYSTEM.
STANDARD
REINFORCED CONCRETE BRIDGE

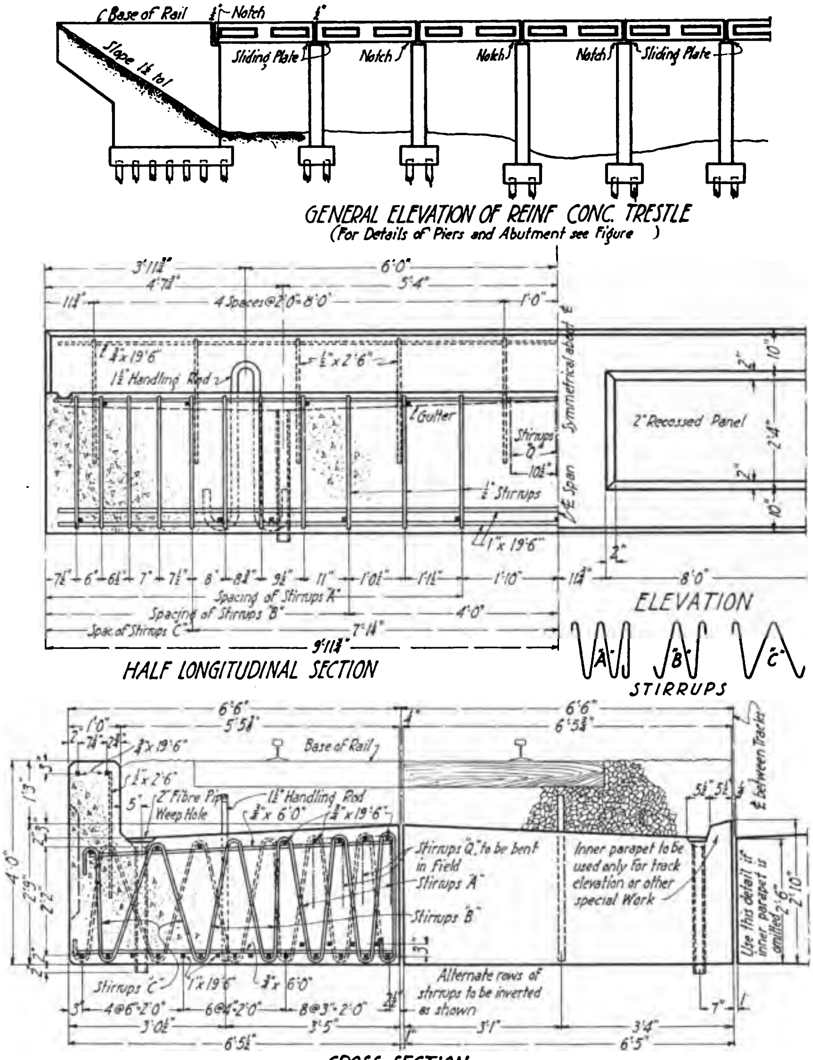
FIG. 8.



STANDARD 8 FT. x 6½ FT. ARCH CULVERT (FOR FILLS UP TO 40'0")
C. M. & ST. P. RY
FIG. 9.

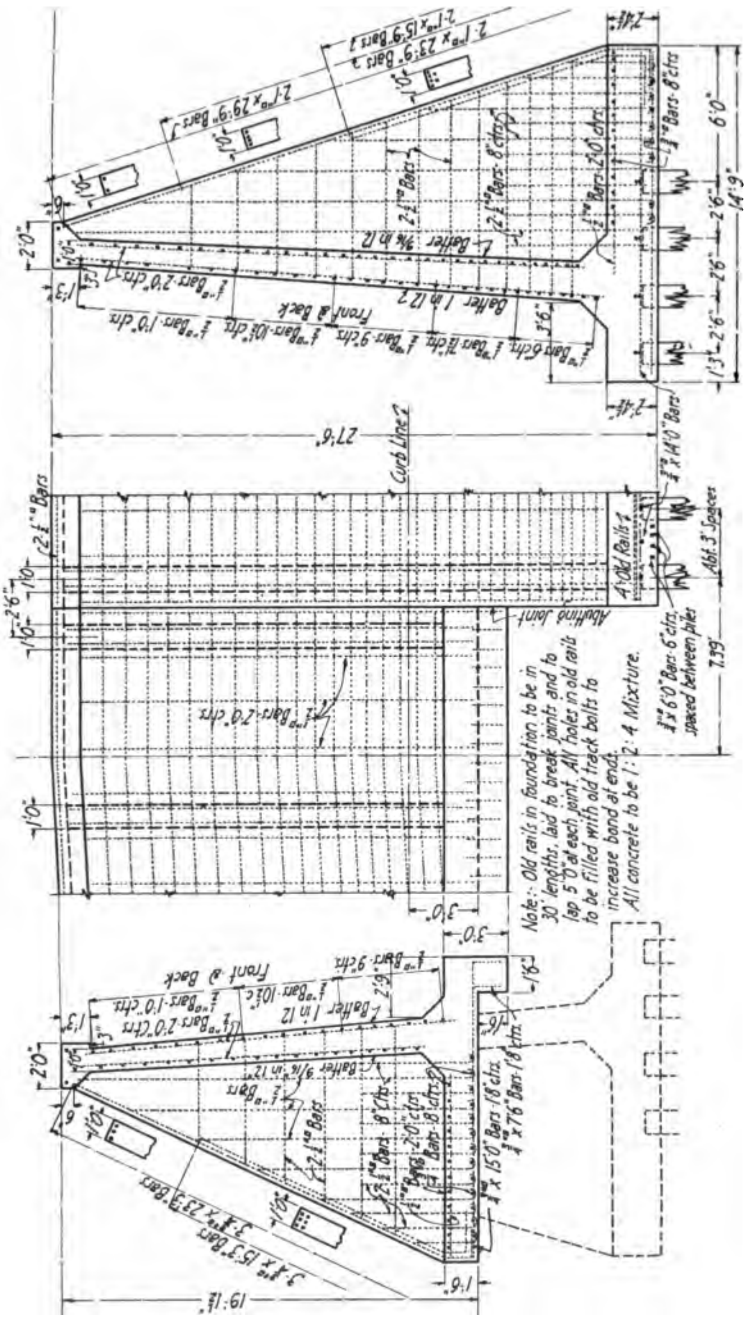


DETAILS OF PIERS AND ABUTMENT (For General Plan & Details of Typical Slabs, see Fig. 11)
C. M. & St. P. Ry. - REINFORCED CONCRETE TRESTLE
FIG. 10

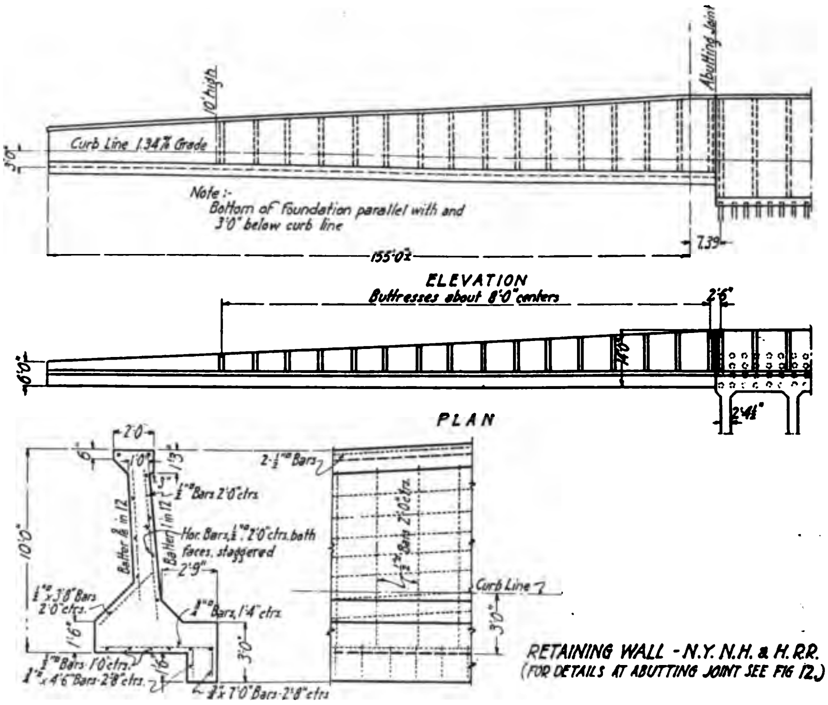


C. M. & St. P. Ry. - TYPICAL REINFORCED CONCRETE TRESTLE SLAB (20' Span)

FIG. 11.



DETAILS AT ABUTTING JOINT OF WALL SHOWN IN FIGURE 13
RETAINING WALL - N.Y.N.H. & H.R.R.
FIG. 12.



Abutting Joint
10' high
Curb Line 1.34% Grade
3'0"
Note:-
Bottom of Foundation parallel with and
3'0" below curb line
155'0"
7.39
ELEVATION
Buttresses about 8'0" centers
2'6"
6'0"
14'0"
PLAN
2'4½"
2'0"
1'0"
10'0"
Batter 8 in 12
Batter 1 in 12
Hor. Bars, ½" 2'0" ctrs. both faces, staggered
2'9"
Curb Line
3'0"
RETAINING WALL - N.Y. N.H. & H.R.R.
(FOR DETAILS AT ABUTTING JOINT SEE FIG 12.)

FIG. 13.

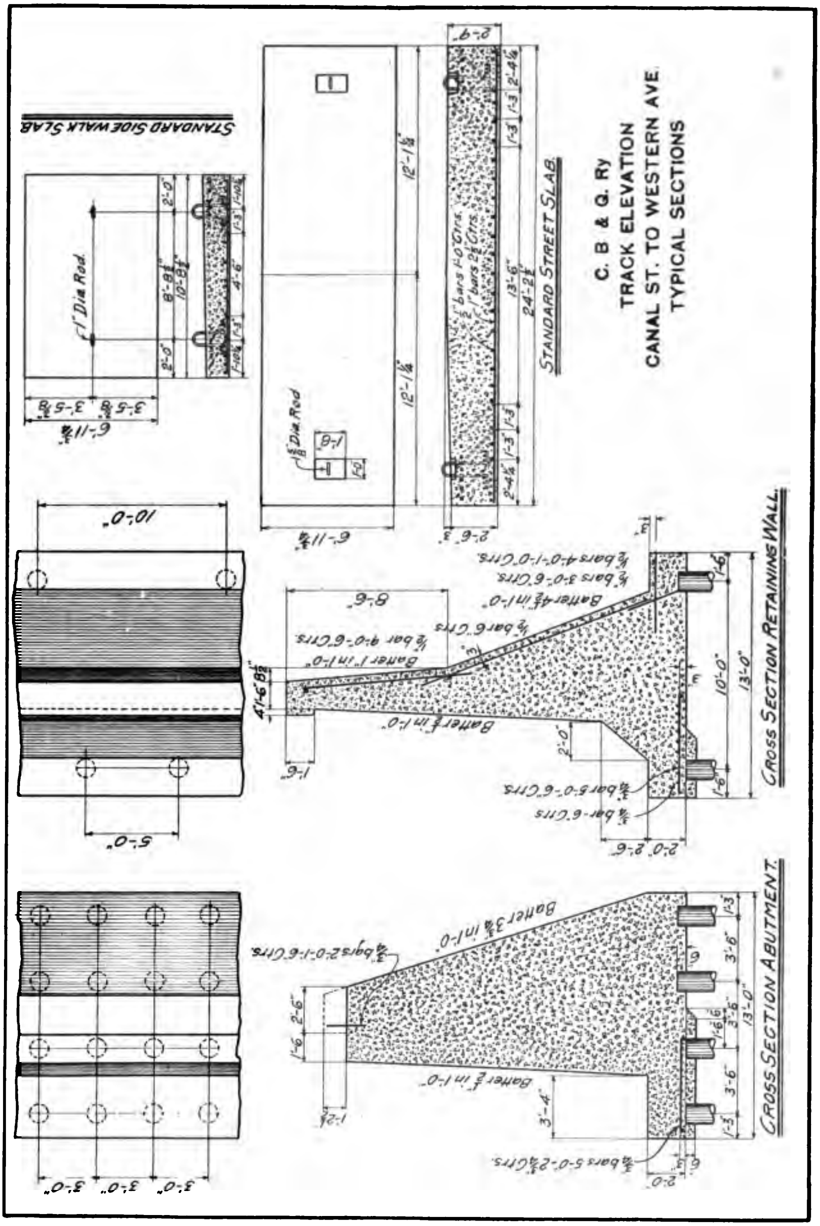
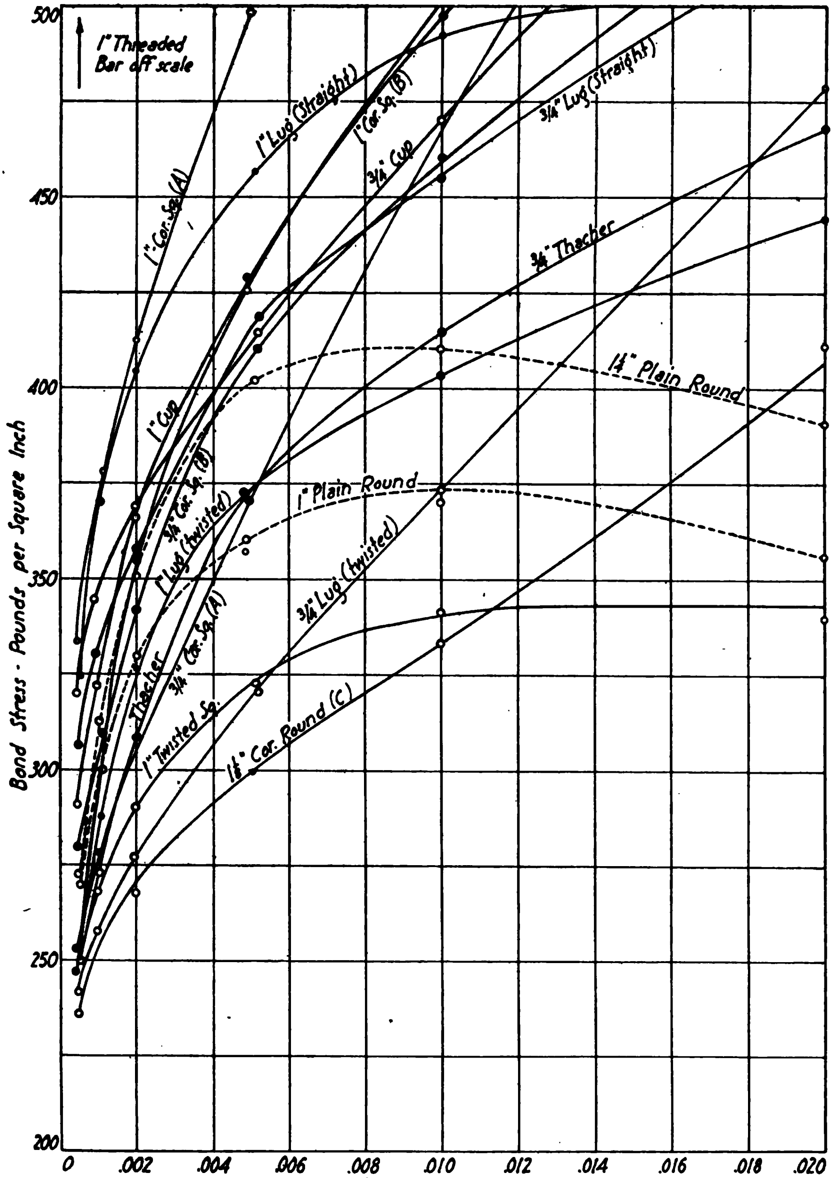
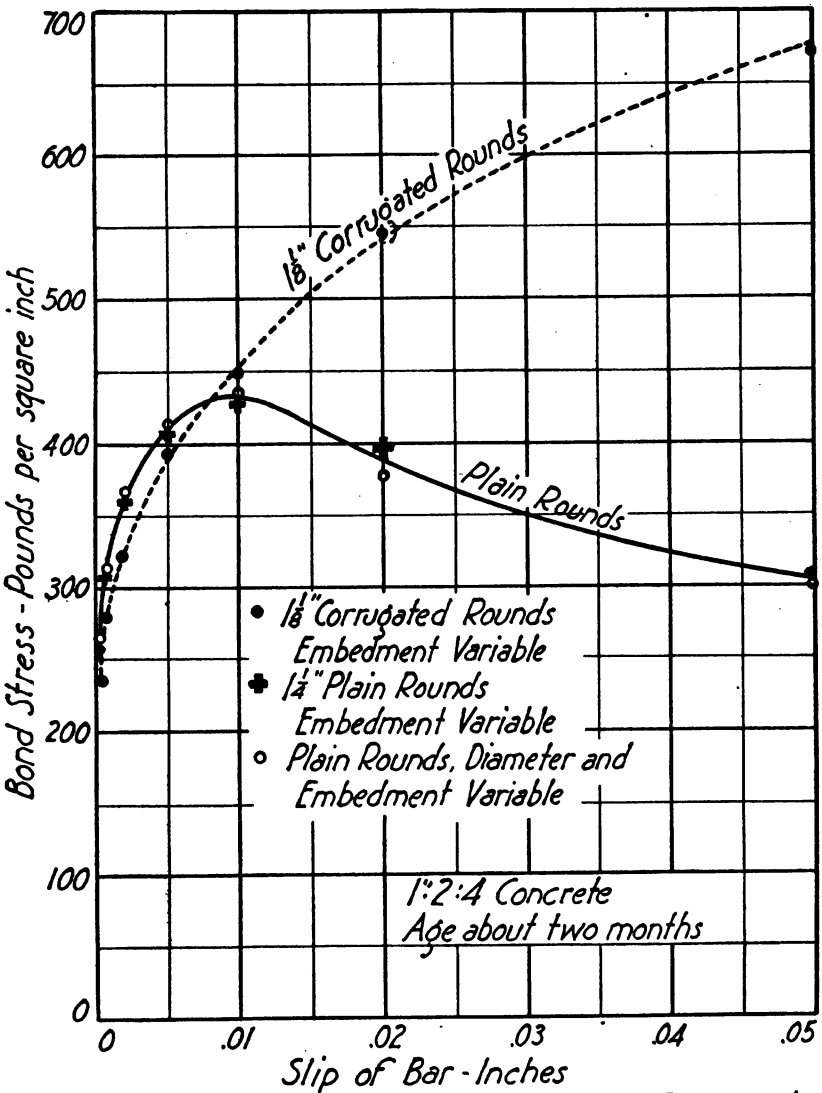

C. B & Q. Ry
TRACK ELEVATION
CANAL ST. TO WESTERN AVE.
TYPICAL SECTIONS
STANDARD STREET SLAB
STANDARD SIDE WALK SLAB
CROSS SECTION RETAINING WALL.
CROSS SECTION ABUTMENT.

FIG. 14.



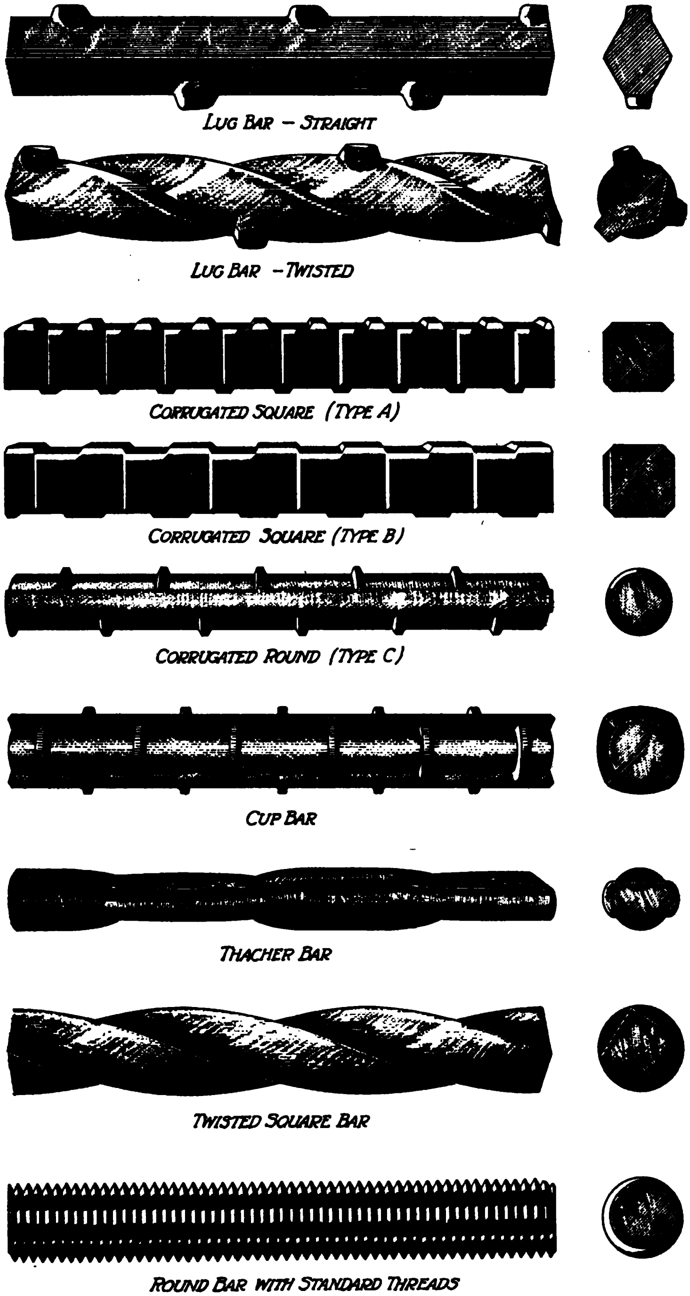
Load-slip Curves from Pull-out Tests with Deformed Bars
from
"Tests of Bond between Concrete & Steel"
Bulletin No. 71, Engineering Experiment Station, University of Illinois.

FIG. 15.



Load-slip Curves after eliminating Size of Bar and Length of Embedment
from
"Tests of Bond Between Concrete and Steel"
Bulletin No. 71, Eng. Exp. Sta., Uni. of Illinois.

FIG. 16



Deformed Bars Used in Pull-out Tests

FIG. 17.

DISCUSSION.

(Subject No. 4, Reinforced Concrete Bridges.)

L. D. Hadwen:—I would like to say that in conversation with Mr. Dalstrom, recently, he advised that he would send in some revised figures. He has much data coming in, and with such a good start it seems to me that the work should be continued. In a letter just received, Mr. Dalstrom gives some revised figures, and also suggests a discussion of the specifications for the class of steel used. I think perhaps it would be well for the secretary to read this discussion which Mr. Dalstrom submits as an introduction to the discussion of the committee report. Although it is a matter that can not be discussed off hand, it ought to be thought of in connection with this report.

O. F. Dalstrom (By letter):—The committee made no special effort to learn the specifications for reinforcing material adopted by the different railroads, confining its inquiries to the form of bar and the kind of material—billet stock or rerolled.

In the specifications, plans and other data received, however, there is found a tendency to accept the recommendations of the American Railway Engineering Association, a number of railroads having adopted this section of the A. R. E. A. specifications without modification. These specifications allow either structural steel or high carbon steel with ultimate strengths of 50,000 and 88,000 lbs. respectively, and an elastic limit not less than 60 per cent of the ultimate strength. But the movement toward the adoption of a standard specification for bars is by no means general. The grades of steel specified on different railroads vary from rivet steel to high-carbon steel with an elastic limit of 50,000 or more.

There is a wide range in the physical properties of steel manufactured under such widely differing specifications. From this it is evident that the same considerations have not governed in determining the grade of steel to be adopted. One group of engineers specifies high-carbon steel, using higher working stresses in the designs, with resulting economy in material. Another group discards high-carbon steel as unsafe on account of brittleness under shock, and specifies rivet steel as a precaution against the effects of impact and vibration from moving loads. A third group specifies steel of the same grade as that required

for structural material in steel bridges, which is a grade intermediate between rivet steel and high-carbon steel. No doubt the adoption of this intermediate grade is based on sound reasoning, but to the advocates of either of the other grades it looks like a compromise between the dislike of rivet steel and the distrust of high-carbon steel.

Rivet steel is a product developed to meet the requirements of riveting in steel structures. It is a soft, ductile steel, low in carbon, with an ultimate strength of 50,000 to 55,000 lb. It can be worked cold, and is not injured by being highly heated in rivet furnaces. To withstand the heating necessary for riveting it must be low in sulphur; it should also be lower in phosphorus than structural steel. These restrictions in chemical composition, and the peculiar physical properties, place rivet steel in a class by itself. The property which recommends it for adoption as reinforcing material is its toughness; and this is acquired at the cost of strength, which must be made up by increasing the percentage of reinforcement in the structure.

High-carbon steel is a hard steel with high ultimate strength and a correspondingly high elastic limit. It is economical reinforcing material, because its high elastic limit permits a high working stress, and this property is not an element in the cost of this grade of steel. There is little difference between the cost of high-carbon steel and that of the softer grades, such as structural steel. The inherent defect of high-carbon steel is its brittleness under shock, and on this account it is looked upon with some distrust as a reinforcing material for structures subject to impact and vibration.

This distrust of high-carbon steel does not appear to be justified when we consider the conditions of loading of reinforced concrete structures; the distribution of the live load by the ballast, fill and concrete; the number of bars over which the live load is distributed, so that the security of the structure is never dependent on the strength of a single unit, and the massiveness of the reinforced structure. These are conditions that make the effect of impact a less important consideration in reinforced concrete structures than in steel structures, whether we regard impact as the sudden application of live load or as the effect of overbalance in the drivers of the locomotive. Impact must be considered in structures close under the rail, such as deck slabs and culverts with little or no fill. But with a proper

impact formula requiring increased reinforcement in such structures, high-carbon steel with an elastic limit of 50,000 to 55,000 lbs. should make the structure as safe as reinforcement with softer and tougher grades.

SUBJECT NO. 6.

MECHANICAL COALING STATIONS.

REPORT OF COMMITTEE.

[This report was received after the convention and is published here for the information of the members. Written discussions are invited for publication in next year's proceedings. A short time will also be given to the discussion of this report at the next convention in connection with the report on small coaling stations.—Secretary.]

Your Committee presents herewith a report on mechanical coaling plants and wishes it understood that this is merely a progress report covering the general features of the different types of coaling plants in use on railroads. We suggest, that a new committee be appointed to enlarge on this very important subject during the coming year. The complete report should show important details of different degrees and compare the probable life of steel and re-inforced concrete in coaling stations. It should give operating costs in detail as well as the cost of the investment in each type of plant.

General.

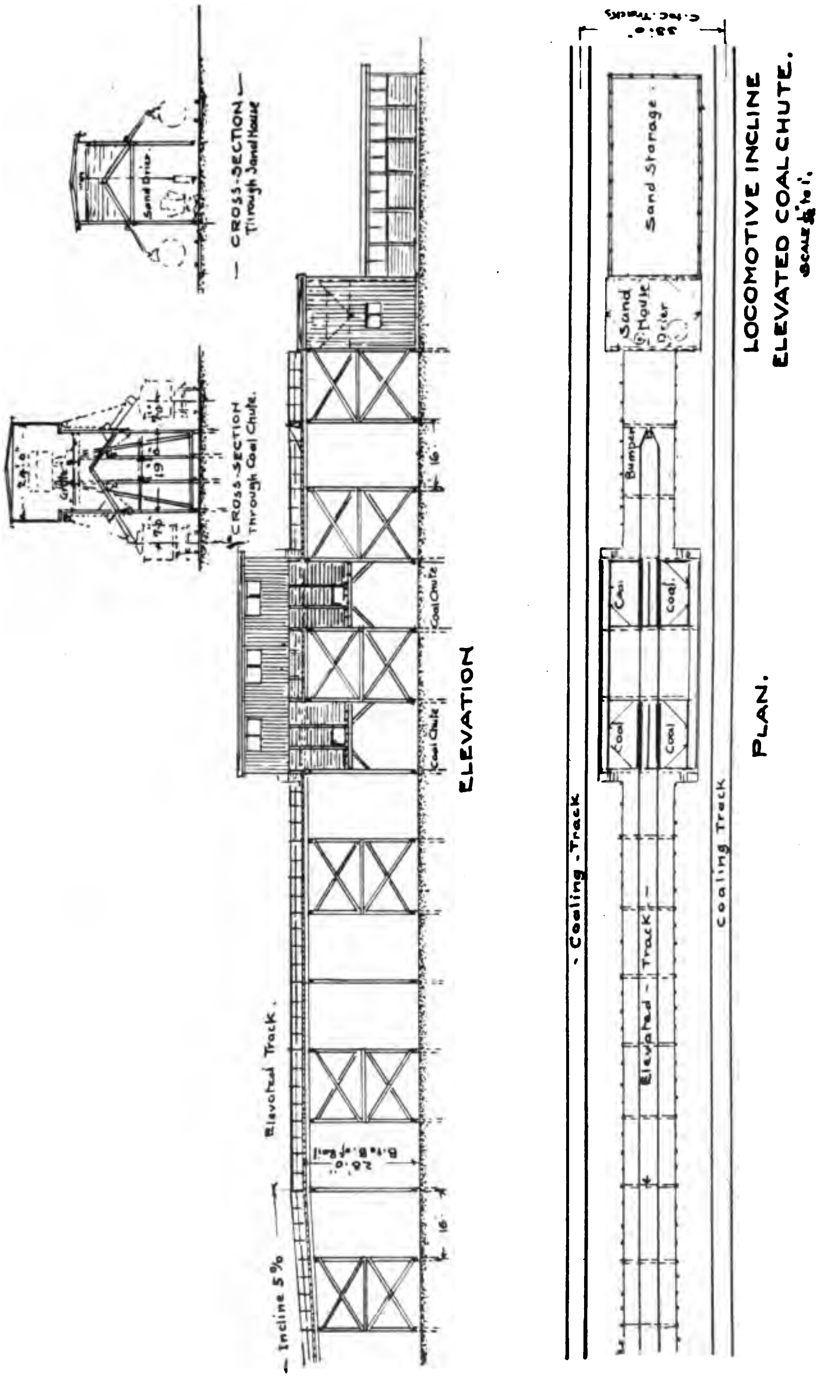
As the cost of handling coal for engines on railroads amounts to a large sum annually, it is essential to investigate the different methods employed and to ascertain the cost of this service, to determine, if possible, the most desirable plant to use at a given place.

There are a very large variety of coaling plants in use by railroads, but the ones most commonly found are of the following types: The incline, the balanced bucket, the chain bucket, the traveling crane, the locomotive crane and combinations of these.

In order to keep a check of the amount of coal used by each engine, weighing or measuring devices are sometimes built in connection with stations. So far no satisfactory device has been found for this purpose, but it is hoped that either one or the other of the devices mentioned will soon be perfected and prove reliable in all respects.

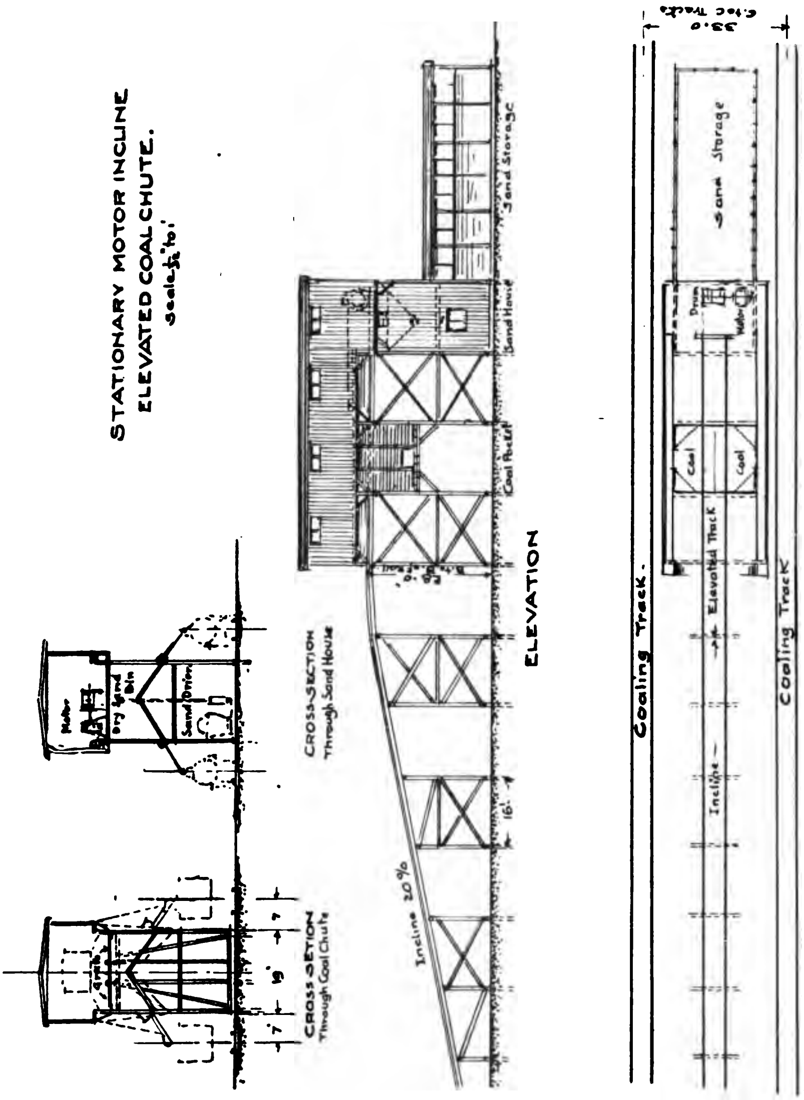
One great difficulty experienced in all coaling stations is in breaking the coal into lumps of the proper size. For this purpose all chutes are either provided with crushing machines or grate bars, neither of which is satisfactory. The crushers usually provided break the coal too fine, thereby causing too much slack, while the grate bars through which the coal is broken up and driven by hand, are not flexible enough, owing to the different qualities of coal received at the plant, with the result that the coal is either too fine or too coarse, thus causing complaints from firemen and giving them excuses either for burning too much coal or for not making the engines steam properly.

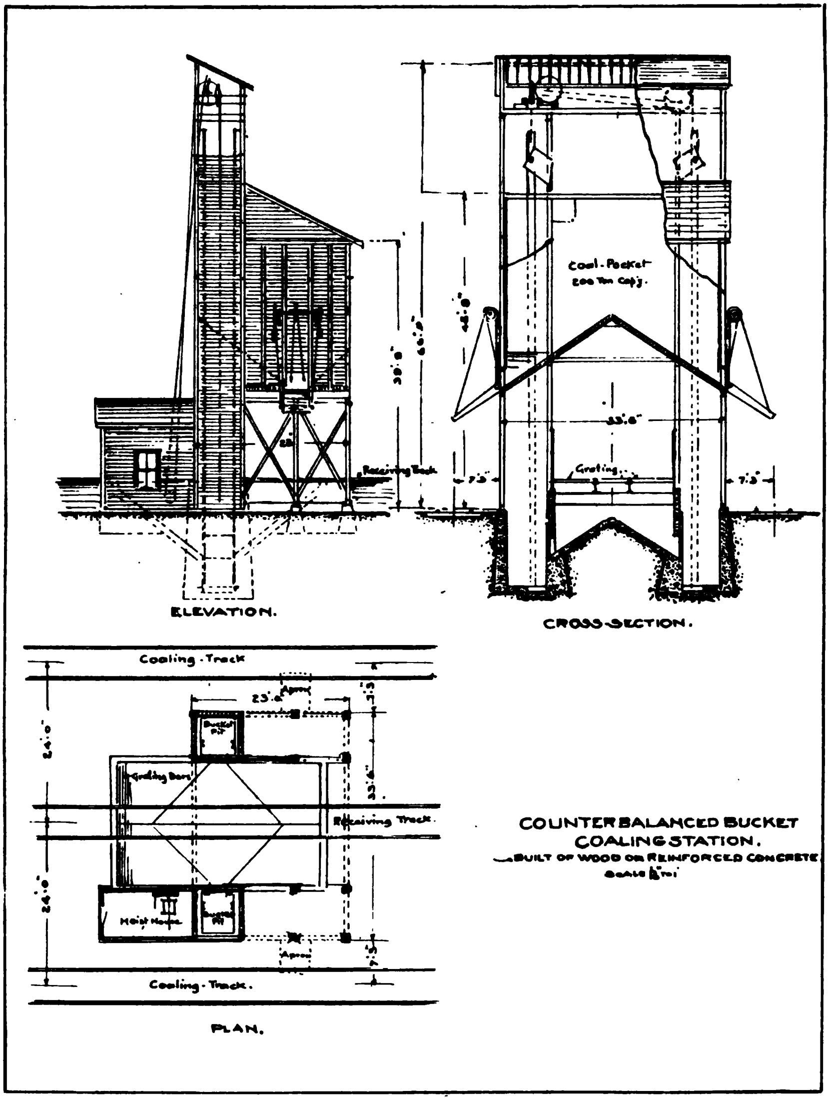
The materials used in the construction of these plants are either timber, steel, reinforced concrete or a combination of these. As plants built of timber are liable to combustion, it is preferable to use either steel or reinforced concrete. Timber is becoming so expensive, that in all probability small plants can be built of steel for a sum equal to or not greatly in excess of the cost of lumber.


CROSS-SECTION
Through Sand House
Sand Drier
CROSS-SECTION
Through Coal Chute
ELEVATION
Coal Chute
Coal Chute
Elevated Track
Incline 5%
Coaling - Track
Elevated - Track
Coaling Track
Bumper
Coal
Coal
Coal
Coal
Sand House Drier
Sand Storage
PLAN.
LOCOMOTIVE INCLINE
ELEVATED COAL CHUTE.

Locomotive Incline Elevated Chute.

The incline type of coaling plant has been in use in the United States for a great many years and has given satisfaction. It consists of an elevated bin in which coal is stored. To reach this elevated bin, a long incline on bents is constructed. Cars of coal are pushed up this incline by an engine and emptied directly into the bin. As this type of coal chute is the simplest of all, with no machinery, it is the cheapest to operate, provided self dumping cars are used. It takes but a few minutes for an engine to elevate the coal by pushing cars up the





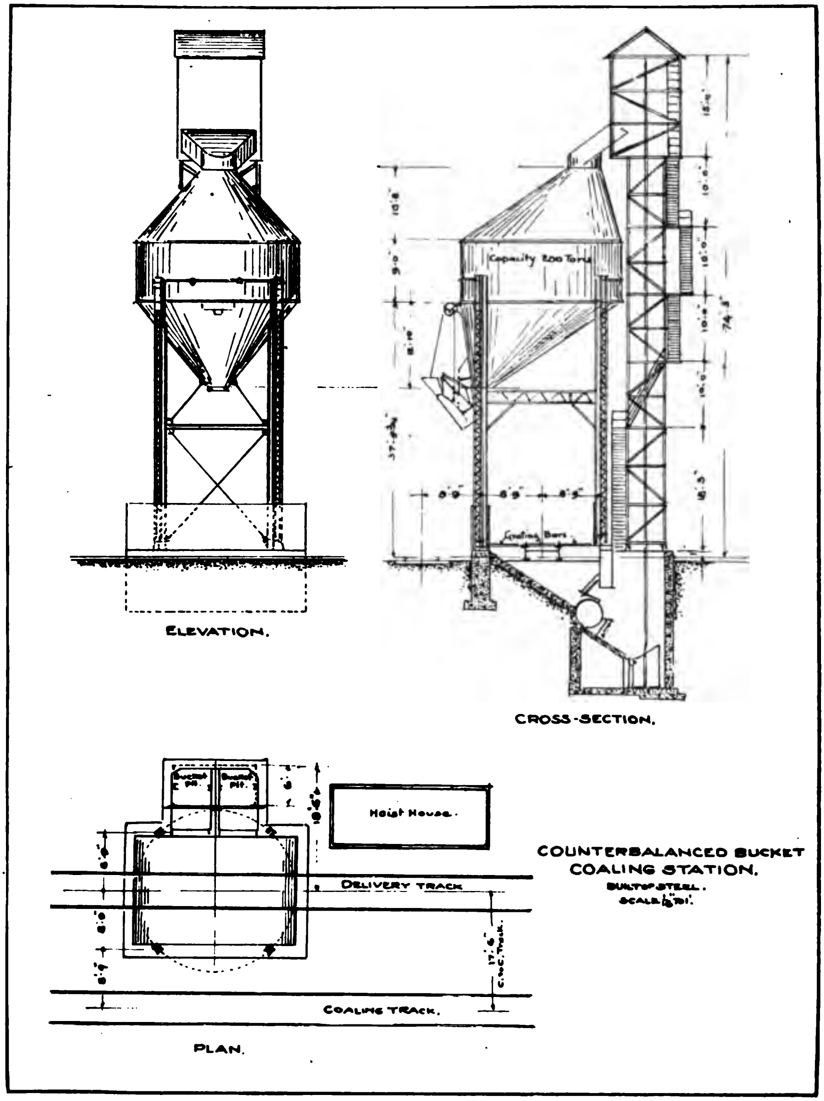
COUNTERBALANCED BUCKET COALING STATION.
BUILT OF WOOD OR REINFORCED CONCRETE

incline, and then it is only necessary to open the bottom of the cars to empty the coal into the bins.

One great advantage of this type is that the coal is handled but once, and consequently is not broken up and pulverized as when handled in the other types. The objection to this style of plant is the great amount of space occupied by the incline. The height of the rail over the elevated bin is at least 30 feet above the tracks, consequently, if the incline is built on a 5 per cent grade, which is the steepest that should be used, the length of the incline will, where the coaling track is on a level grade, be approximately 600 ft. Some level space must also be

provided on each end of the coal bin house, so it is readily seen that where space is not available, this style of plant can not be used.

In addition to the storage bin for coal, a storage bin for damp sand should also be provided, and an elevated bin for dry sand. Damp sand is unloaded by hand from cars to the lower bin and it is wheeled from this point and placed in the drier by hand, after which it is blown by compressed air into the elevated bin.



COUNTERBALANCED BUCKET COALING STATION.
BUILT OF STEEL.
SCALE 1/8" TO 1'.

Stationary Motor Incline Elevated Coal Chute.

A modification of the previously described coaling plant may sometimes be used by making the length of the incline considerably shorter, and increasing the grade to 20 per cent. With such a steep grade, locomotives can not be used, so it is necessary to provide a stationary hoisting engine to pull the cars up the incline.

Incline chutes of both types are the most economical in maintenance and operation, while the cost of construction for storage capacities of 500 tons and over is less than for any other type. The operating cost should be the least of any regardless of the capacity of the chute. Neither of these chutes lends itself to steel construction and should therefore be built of timber or reinforced concrete, preferably the latter. However, the incline may be built of timber and the remaining portions of reinforced concrete.

Balanced Bucket Coaling Station.

This type consists of an elevated bin built on top of a concrete receiving hopper, which in part supports the elevated bin; the coal is dropped from self-dumping cars into the concrete receiving hopper and from there it runs through an opening controlled by a small door into a large iron bucket that holds not less than one ton of coal. As soon as the bucket is filled, it is hoisted to the upper bin and is upset at the proper time by means of guides dumping the coal into the bin. Generally there are two buckets, one ascending, while the other is descending, so that the dead weight is counteracted.

These types of coal chutes adapt themselves very readily to plants having a capacity of about 300 or 400 tons. They can be built of wood, steel or reinforced concrete, and where the capacity of the elevated bin does not exceed 300 tons, they can be built of steel in circular form, somewhat similar to water tanks for a cost not to exceed that of timber. If built in rectangular form, the elevated bin should be made of reinforced concrete in preference to wood, but not of steel as the cost would then be as much as reinforced concrete and the structure would not be as enduring.

The cost of a reinforced concrete structure will be approximately 40 per cent more than that of timber. The maintenance and operation of these plants are economical, as the machinery is of simple nature.

The Link Belt Conveyor Coal Station.

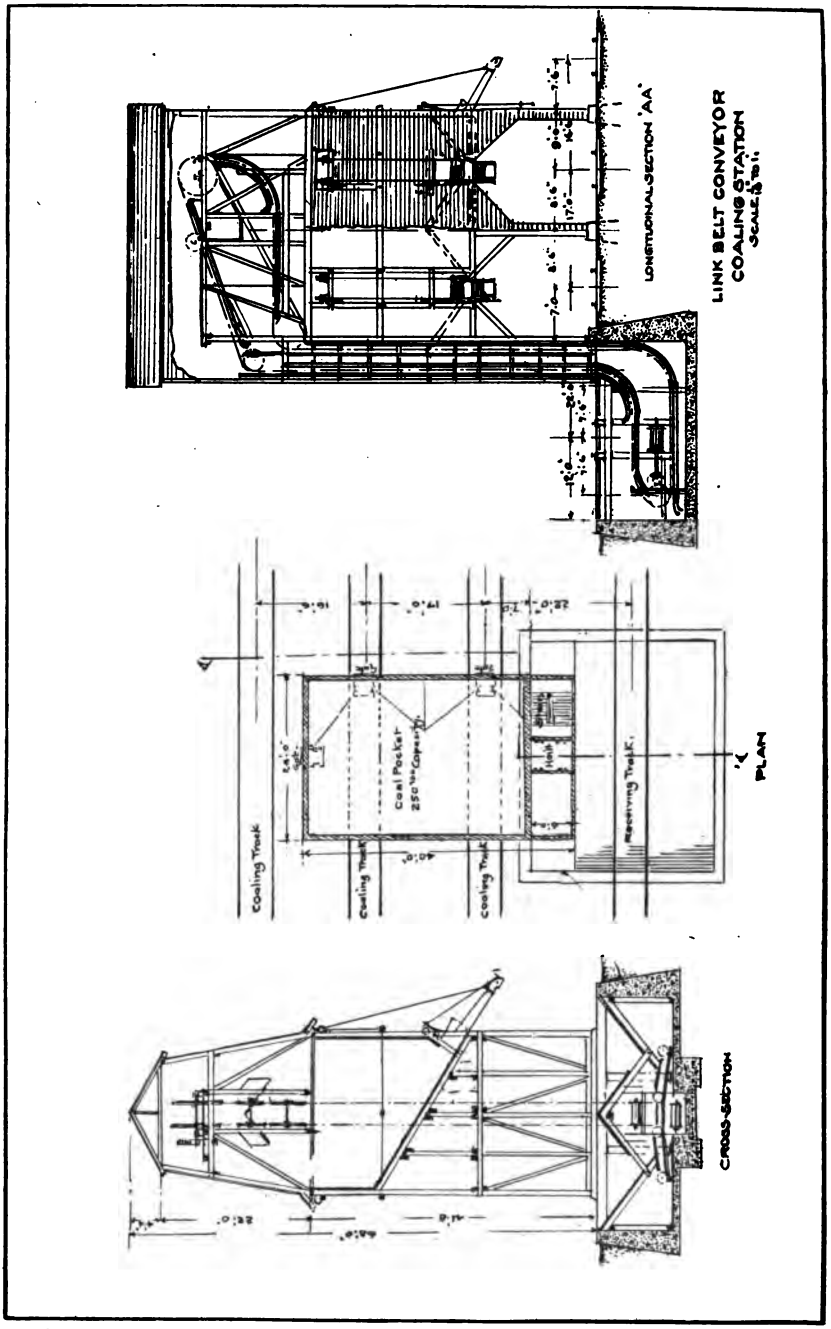
The continuous chain bucket type sometimes called the "Link Belt" is adapted to locations where the space is very limited as in large terminals. It consists of an elevated bin built on one side of a receiving hopper. Coal is delivered to the concrete receiving hopper in self-dumping cars which empties itself through properly controlled openings into a continuous line of buckets of small capacity hanging on an endless chain which hoist and dump the coal into the elevated bin. The proper material to use in the construction of this type of coaling station is reinforced concrete, as it is continuously in an atmosphere of smoke and the fire hazard is great, since the elevated bin generally covers several tracks.

The sole advantage of this type is its compactness, not only for handling coal, but also for cinders and sand. The disadvantage is that the first cost is exceedingly high and the maintenance excessive.

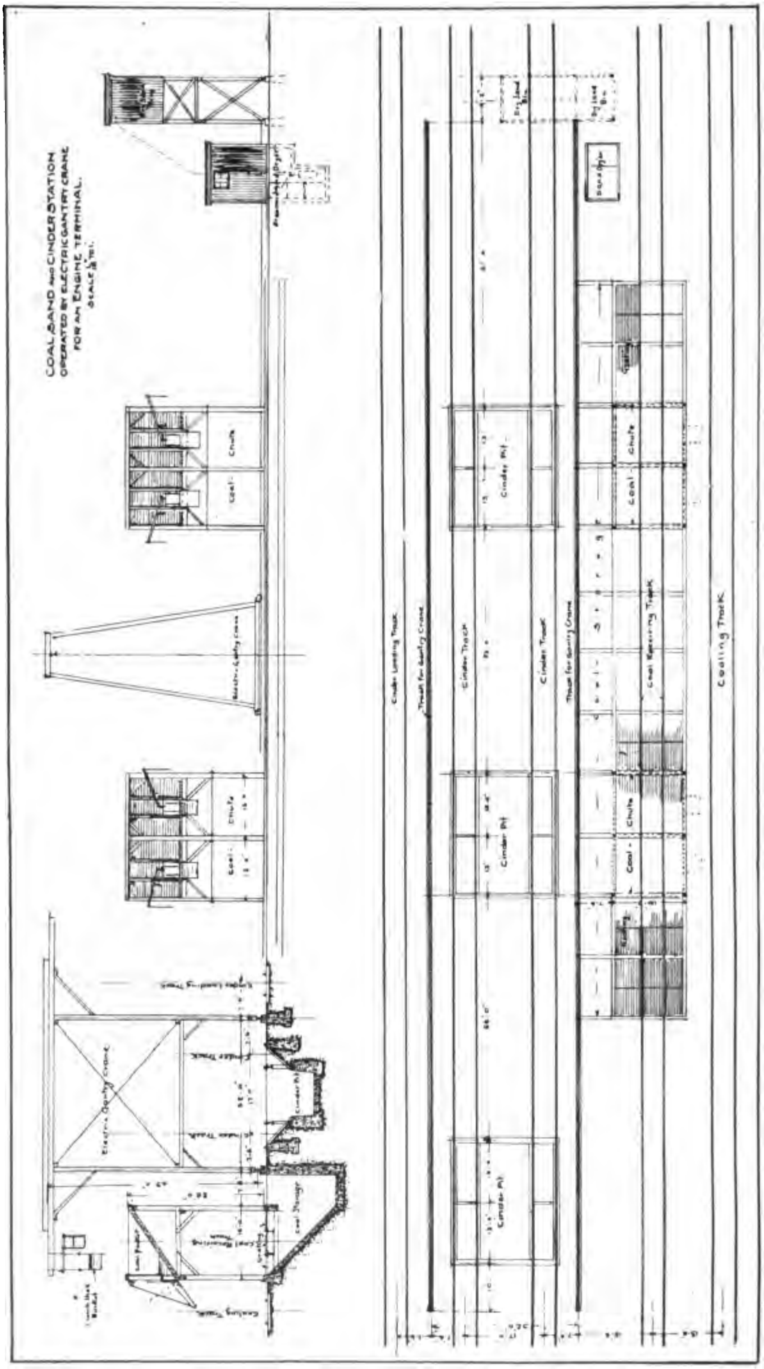
The Gantry or Traveling Crane.

The gantry or traveling crane may be used to good advantage for coaling engines at terminals, provided it can also be used for handling cinders and sand.

The crane should travel on a track built on a concrete foundation. It should be so located that it will handle all material with the least



LINK BELT CONVEYOR COALING STATION


COAL, SAND AND CINDER STATION
OPERATED BY ELECTRIC GANTRY CRANE
FOR AN ENGINE TERMINAL.
Cinder Loading Track
Track for Gantry Crane
Cinder Track
Coal Receiving Track
Coaling Track
Coal
Chute
Cinder Pit

amount of travel and of such height as will enable it to dump coal into elevated coal pockets. It must be able to remove cinders from the cinder pit to cars on adjacent tracks; take coal directly from cars to engine tenders, or put it in elevated bins and also transfer it from the receiving hoppers to engine tenders or elevated bins; and unload sand from cars to the sand drier, or to storage bins, and also transfer it from the storage bins to the sand drier. It should also be of sufficient capacity to lift the ordinary loads that are necessary around an engine terminal.

If the crane is properly constructed, one man in the cab of the trolley hoist can do all the work enumerated above for a large engine terminal during a period of ten hours, and can also fill the elevated bins to provide the coal supply for the night hours. This type of a plant is advantageous, because of its flexibility, its small first cost and its low maintenance. Its use, however, is limited to terminal points.

Locomotive Crane.

The locomotive crane may take the place of the gantry crane. More room is required, as it must be provided with a standard gage track for its sole use. As the locomotive crane handles a bucket on the end of a long boom, it takes more time to do the work than would be required by a traveling crane, and it is a much more complicated piece of machinery, with boilers requiring frequent attention.

The advantages and disadvantages are the same as with the gantry crane, but it is not as economical in first cost, maintenance or operation, as a locomotive engineer is required whose wages are considerably more than those of the operator of a gantry crane. From the standpoint of economy, locomotive cranes should not be permitted if it is possible to use gantry cranes.

Robertson Conveyor.

This type of plant is generally used for handling cinders, but can be adapted with slight modifications for handling coal. It consists of an upright iron frame, with rails attached to it on an incline, upon which an iron box with a hinged bottom travels on wheels. This box descends into a shallow pit over which is placed a small receiving hopper and when filled, it is hoisted by a cable, attached to a cylinder, which is operated by compressed air. The box travels on the inclined rails and the bottom is tripped at the proper place to dump its load into the engine tender. The power to operate the hoist is compressed air supplied by the engine.

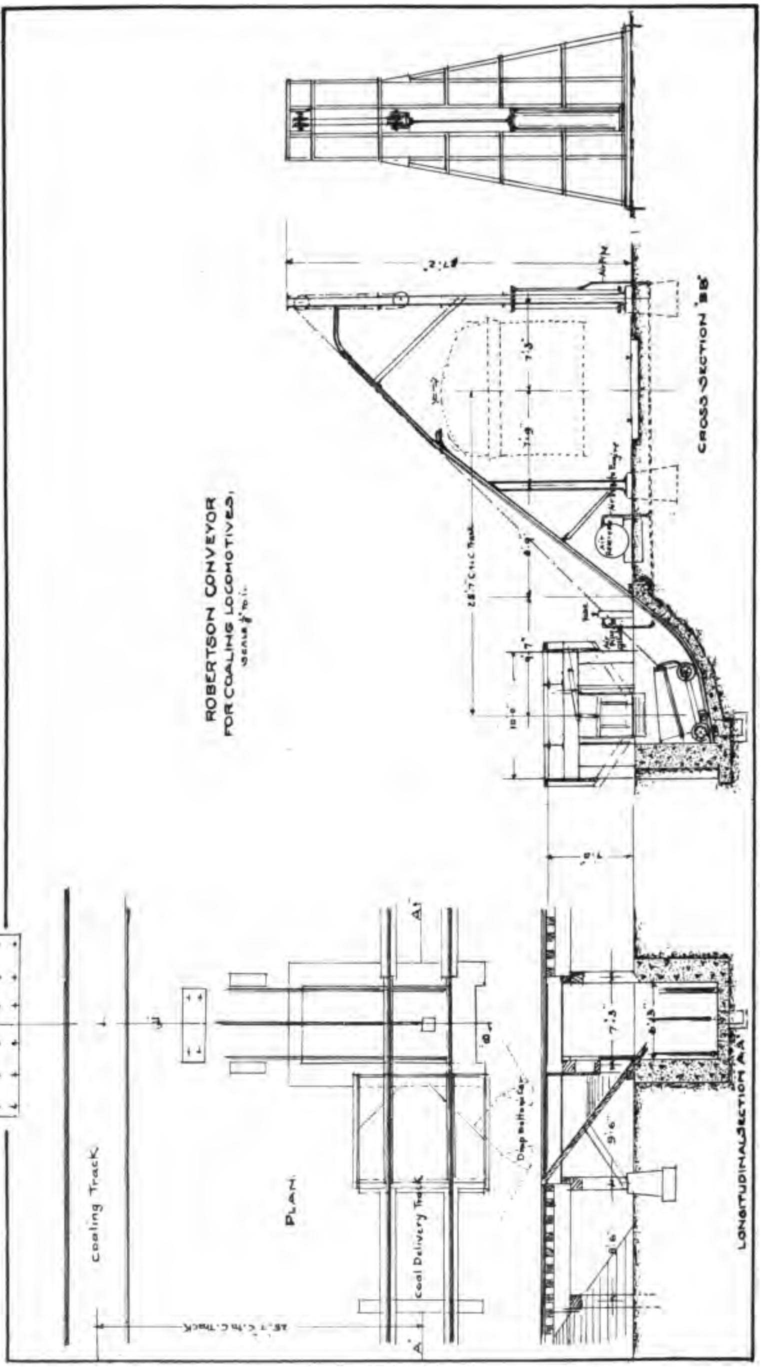
A hopper bottom coal car unloads into the small receiving hopper which hopper is necessary, because when the car is opened up there is no way of controlling the flow of the coal. The coal car is really the storage bin and empties itself in proportion to the amount taken from the receiving hopper.

This kind of a plant may be used to advantage in large yards for coaling switch engines or on branch lines where a limited amount of coal is used.

Summary.

It is very difficult to properly arrive at the cost of handling coal for engines, since each railroad has a different method of keeping these costs. It will generally be found, however, that in modern plants where self-dumping cars are used, the cost of labor, including power, will not exceed 2 cents per ton of coal delivered to the chute and where it is necessary to shovel coal from the cars by hand, the cost of labor will run as high as 10 cents per ton. To this cost should be added the interest on the investment and the cost of upkeep, together with all minor incidental costs incurred by the plant.

It may be taken as a general rule that all plants will handle coal


ROBERTSON CONVEYOR
FOR COALING LOCOMOTIVES
PLAN
Coaling Track
Coal Delivery Track
CROSS-SECTION "BB"
LONGITUDINAL SECTION "AA"

for about the same price per ton, depending almost entirely upon the style of coal cars used in operating the plants, so with these two operating costs in mind it can be readily determined whether it will pay to maintain an old plant or build a new one to take its place. If the old plant can be adapted to the use of self-dumping cars readily, there will be no economy in providing a new one to replace it.

A. O. Cunningham, Chairman.
J. S. Berry.
R. J. Bruce.
C. H. Fake.
F. G. Jonah.
Committee.

SUBJECT NO. 7.

CARE OF TRAFFIC AND THE CONSTRUCTION OF BRIDGES TO ELIMINATE GRADE CROSSINGS.

REPORT OF COMMITTEE.

In preparing a committee report on this subject it seems best to make some preliminary statements to show a reason why railroads in recent years have made very large expenditures for the elimination of grade crossings. The present day policy is directly opposite and in such marked contrast to that which prevailed in the early days of American railroads that a reason ought to be put in print in a paper of this kind, even though it may be stating facts which are well known to most railroad men.

To do away with the dangerous grade crossings is certainly in harmony with the policy of "Safety First," but the old time rules for blowing the whistle and ringing the bell, with flagmen and crossing gates may be considered as proper protection to make a grade crossing safe from a practical standpoint, at a cost far less than that for building a bridge and grading approaches. For a single track or even a double track railroad, this statement is reasonable if the speed and frequency of trains is not too great. With increase in traffic, and when its volume grows to the extent of requiring more than two tracks the ordinary safeguards prove inadequate and every grade crossing becomes a source of danger and a menace to safety, both to the railroad train and to public travel on the street, as well as a source of aggravation and delay to both. The remedy is to eliminate the grade crossing.

The growth of traffic in the more thickly populated districts in our country reached these aggravated conditions some years ago; and in Massachusetts it resulted in a public sentiment which demanded legislation. By Chapter 99—Acts of 1888 of Massachusetts General Court—it was "Resolved that the Governor with the advice and consent of the Council be authorized to appoint three competent and experienced civil engineers who shall investigate and report in print to the next General Court, on or before the first day of February, 1889, upon the subject of the gradual abolition of the crossings of highways and railroads at grade."

The three engineers were duly appointed. They made a very creditable and comprehensive report which resulted in the enactment in 1890 of a general grade crossing law in Massachusetts. Its principal provisions were that either the State, railroad company, a City or Town, desirous of a change might present a petition to the Superior Court of the Commonwealth. The Court to appoint Commissioners to notify all the parties interested, to hold hearings, take testimony, and report their findings. The Court at its discretion to accept or reject the report of these commissioners; and, if ordering a change, the report was approved by the Court, it became law and the duty of all parties in interest to accomplish the work in conformity with such decision.

This general law provided that the total cost should be divided and assessed: 65 per cent upon the railroad, 25 per cent upon the state, and 10 per cent upon the city or town. In 1902 this general law was amended so that if any street railway company had a location and tracks in the highway, the street railway company became also a party

to the proceedings. In such case should an order be issued, the total cost should be divided in the same proportion with provision that the state would be reimbursed by the street railway company a proper amount, to be determined in each case, not to exceed 15 per cent of the cost of eliminating the particular crossing in which it might be interested.

In 1889 the State Legislature of Connecticut enacted a law which made it mandatory upon the steam railroads of that state, to each year eliminate one public highway grade crossing, for each 60 miles of railroad it operated in that state. The railroad company was free to select such crossings for elimination as it saw fit, and bring its petition to the railroad commissioners for the issue of an order. In such case the railroad company was obliged to bear the entire cost of the work, and it was only in a case where a city or town of that state might bring a petition for elimination of a crossing that the city or town would be called upon to bear such a percentage of the cost of the work as the railroad commissioners might order after public hearings, the preparation of a plan and issue of decision and report. Other states have also enacted laws to provide for grade crossing elimination.

It is therefore legislative enactment in harmony with public sentiment, as well as the needs of the railroads for the prompt and safe handling of traffic, that in recent years has caused the elimination of grade crossings; and in so doing, the railroads coöperating with state, city or town, have undertaken works of greater magnitude and cost than were ever considered possible in the early days of first location and construction. This is especially true as applied to the American railroads, where it was absolutely necessary to construct the greatest possible length for the least first cost. Indeed it may be freely stated that when it could be done without actual loss, both the railroad promoters and the locating engineer, as a governing feature, selected ground for the line which would allow of grade crossings of highways in preference to an over or under crossing.

The pictures of the first passenger coaches represent the car bodies as reproductions of the old horse-drawn mail coach bodies mounted on a revised running gear, a vehicle which in appearance, size or weight was not to be considered as liable to menace the public safety. The plans of location of many of the earliest railroads show their location lines extending lengthwise within limits of public streets for considerable distances in cities and towns. These facts clearly show the temper of those times, and how faint a comprehension the community at large in the early years of railroads had of the development which was to come. They had no mind pictures or even dreams of the modern locomotive, long and heavy coaches and the weight, speed and impact of railroad trains of today.

It was well that the enterprise of the pioneers was not discouraged by any such pictures and, however much we may now theorize and regret the location as at first made, when contemplating the cost for eliminating grade crossings, reflection convinces us that taking the railroad mileage as a whole, the growth has been on logical and correct lines. That construction and capitalization at a low first cost was necessary to make the start which secured the development and volume of traffic of today, which produces income sufficient to allow an increased capitalization and to pay for the grade crossing work.

Aside, however, from the consideration of topographical conditions, which might now in certain places have made some alternate railroad locations advisable or better, when considering grade crossing questions; the growth and increase of cities have in many other localities made present conditions entirely different from any that could possibly have been anticipated at the time of the first location.

The greatly increased value of land in the cities has in the great majority of cases become the ruling consideration when studying and planning grade crossing problems in places where the grade crossings

are many and near together; and it is generally found more economical to make the best possible use of the old location, rather than to make radical departures from it. Under such circumstances, a limited width of land owned, frequently makes necessary the construction of railroad trestle structures or retaining walls on land lines and solid filling between walls, in addition to the building of the bridges required at the crossings.

The performance of construction work and the maintenance of traffic within such restricted limits at once create greatly involved problems of "how best to accomplish the desired results within reasonable limits of cost, and to do it safely, promptly and at the same time secure solid, permanent work." "Safety First" must be the ruling consideration. Good work must always be secured to make permanent the object sought. To secure prompt performance it is necessary to have an intelligent plan, well studied and worked out in most details, well in advance of the performance of the work; to have a well organized and properly directed working force, properly equipped with machinery, tools and appliances. Too much emphasis cannot be laid on the absolute necessity of having always available, and in season, a properly purchased and sufficient supply of the materials needed to go into the work.

When these preliminary conditions are complied with, and a force of faithful willing workers employed, the result attained must be economical as to cost, as far as cost should enter into the consideration of such a problem. The continuance of regular traffic within restricted areas and width of location, at the same time that construction work may be in progress, greatly increases the difficulties of accomplishing it, and it is necessary to provide money sufficient for an increase much above ordinary unit costs. As the ultimate cost reflects the measure of success achieved in all business and structural undertakings, it is evident that consideration of cost must always be on the mind of the man who directs, even when as in this case he must give preference to the "Safety First" rule.

The study for eliminating a single grade crossing in an outlying district away from thickly settled places in cities or towns can hardly be taken as an example to be used in writing up this subject; for while it may have much in common with city work from a construction standpoint, ordinarily it would not bring up questions regarding "care of traffic" except as it might bear on the question as it relates to the proper and safe support of tracks and clearance for trains while work is in progress.

That which has been already reported and printed on pages 241 to 265 inclusive in the Proceedings of 1913 on the subject of "Temporary structures for supporting track," so thoroughly covers all that can be written on the subject, from a construction standpoint as it is related to care of traffic, that it is not necessary or advisable in this paper to rehearse that phase of the subject.

The proper answers to the questions of "How to abolish grade crossings," is that each case must be studied and treated on its merits according to local conditions, like any other construction proposition.

With ruling theoretical conditions as assumed in the foregoing for eliminating the grade crossings, and performing the work on an original location, the practical and physical conditions which enter into the subject may be classed, and speaking generally with the railroad on a fixed location, all the problems in any locality must come under one general rule, with secondary classes as follows, viz.:

The General Rule.

No. 1. To change the grade of either railroad or highway and build bridges, or to abandon the highway.

Secondary Classes.

No. 2. To elevate the railroad over a single street or a number of streets which may be near together.

No. 3. To depress the railroad under a single street or a number of streets which may be near together.

No. 4. To elevate the street or streets over the railroad with its grade unchanged.

No. 5. To elevate the railroad over the street with its grade unchanged.

No. 6. To excavate beneath the railroad for the full height needed for the street to pass under with railroad grade unchanged.

No. 7. To excavate for the street in part, and elevate the railroad in part to insure the clear height.

No. 8. To excavate and lower the railroad in part and elevate the street in part to insure the clear height needed.

Reasonable classification on this subject can scarcely be outlined further than this.

Any change of railroad grade by raising or lowering results in changes for considerable lengths of track, proportionately greater than the lengths required for highway changes as the rate per cent of allowable railroad grades may be less than the rate per cent allowable for highway grades. Increased length of change in the abstract means an increase in quantities and cost so that as a first proposition it may be considered that a change of street grades can be accomplished usually for less cost than a change of railroad grade.

Where a proposition to eliminate at one time a number of grade crossings in a city or town is undertaken, it is evident that a variety of combinations of the above named seven secondary classes will result, and the study "care of traffic" is made complex accordingly, proving again that each case must be studied and treated on its own merits. When we reach this conclusion, it is evident that a description of the way of handling traffic on any one large grade crossing proposition which has been finished successfully and safely is a proper object lesson for use in illustrating this subject. To do this intelligently a description of the work itself is necessary.

As division engineer in charge of maintenance of way on the Boston division, N. Y. N. H. & H. R. R., the chairman was actively interested and acquainted with work performed in 1910-11, for the elimination of grade crossings in Boston, on the third district between Savin hill and Neponset, on the main line; and from Harrison Square to Field's Corner, on the Shawmut branch. By this work ten highway grade crossings were eliminated in a thickly populated district on a line where trains are very frequent. The grade of the railroad was raised, and one highway abandoned. The No. 2 of the above named secondary rules applies to nine of the crossings, the No. 4 to one crossing, the No. 5 to two crossings, and the No. 7 to seven crossings.

The length of the grade change on the main line was 9,900 ft., and originally there were four main tracks from Savin Hill station to Harrison Square, a distance of 3.200 ft.; and two main tracks for the remaining distance to Neponset. The original grade of the main line within the changed limits was slightly undulating, varying from a general level, nowhere more than five ft. with easy grades. The new main line grade from Savin Hill, going south, ascended at a rate of 0.57 per cent for 2 000 ft.: then with easy rates for the next 4.700 ft., and a descent for the next 2,400 ft. at the rate of 0.58 per cent. Within the 4,700-ft. length the elevation of new grade above the old varied between 15 ft. and 18 ft.

The length of the grade change on the Shawmut branch was 3,150 ft., and there are now and formerly were two main tracks. This branch diverges from the main line at Harrison Square where the grade was raised 15.44 ft. Going south on the branch, the new grade ascends for the first 2,000 ft. at a rate nowhere in excess of 0.70 per cent, and at an

ELIMINATION OF GRADE CROSSINGS BOSTON, MASS.
SAVIN HILL TO NEPONSET
AND
HARRISON SQUARE TO FIELDS CORNER.

MAIN LINE

NORTH END 4 TRACKS

Alignment		Survey Station	Passenger Stations and Grade Crossings Eliminated No. Street Name	Width of Street Feet	Crossing Angle	For 14 Ft. Clear Changes Made: Raise Track Feet	Cut Surface Feet	Elevations Base of Rail New Grade of Railroad
TANGENT		148	SAVIN HILL					EL.
2605.93 FT.		149	CHANGE OF GRADE BEGINS					20.20 VERT. CUR.
		153						20.35
		173	1 FREEPORT ST. NORTH UNDER	50.	80°	15.	2.50	31.75
3° CURVE LFT.	P.C.	175+05.93						VERT. CUR.
1697.64 FT.		177						33.45
		179+15.	JUNCTION SHAWMUT BRANCH					
		183	HARRISON SQUARE					
		187	2 PARK ST. UNDER	47.	50°	16.	1.50	36.25 VERT. CUR.
		191						36.45
	P.T.	192+03.57						
TANGENT		202+	3 MILL ST. UNDER	50.	80°	17.33	0.	
5596.43 FT.		216+	4 FREEPORT ST. SOUTH UNDER	40.	60°	16.81	0.	
		217	POPES HILL					31.77 VERT. CUR.
		220						30.60
		224	5 HAMLINS CROSSING UNDER	38.5	90°	12.81	2.50	
		244						16.71
		245+69.47	6 COPLEY WAY OVER	50.	85°	0.	ST. SURFACE 26.71 ABOVE B.R.	VERT. CUR.
		248	CHANGE OF GRADE ENDS					16.30
		250	7 WALNUT ST. ABANDONED					
		252	NEPONSET					
9900. FT. = LENGTH OF MAIN LINE GRADE ELEVATION								

AT STA. 248+ MILTON BRANCH DIVERGES TO RIGHT.

SHAWMUT BRANCH

2 TRACKS

Alignment		Survey Station	Street Name	Width of Street Feet	Crossing Angle	Raise Track Feet	Cut Surface Feet	Elevations
TANGENT 141.15 FT.		O = 6 FT. RT. OF MAIN LINE STA. 179+15				15.44		34.05
10° CURVE RT.	P.C.	1+41.5						
773.75 FT.		4	HARRISON SQUARE					35.10 VERT. CUR.
		5	8 CLAYTON ST. UNDER	40.	45°	15.	2.	35.59
TANGENT 342 FT.	P.T.	9+14.9						
6° CURVE RT.	P.C.	12+57.58						
239.42 FT.		14+	9 ADAMS ST. UNDER	50.	60°	15.5	2.	
TANGENT	P.T.	14+97						
216.12 FT.		17+10	10 DORCHESTER AVE. UNDER 2 ST. RY. TRACKS	56.	80°	14.5	3.	
6° CURVE LFT.	P.C.	17+13.12						
		18−						44.51 VERT. CUR.
		22−						44.51
		23	FIELDS CORNER					
		24−	11 FREEMAN ST. UNDER	30.	85°	8.5	8.5	
		28−						40.31
		29+	GENEVA AVE. UNCHANGED BRIDGE UNDER			UNCHANGED		
		31+50	CHANGE OF GRADE ENDS.					41.68
		32+	E.D.T. = TEMPORARY CROSSOVER.					

3150. FT. = LENGTH OF SHAWMUT BRANCH GRADE ELEVATION.

elevation of about 16 ft. above the old grade. For the remaining distance of 1,150 ft. it descends at a rate nowhere exceeding 0.70 per cent to unite with the old grade.

In place of a map and profile, the accompanying tabular sheet affords information in detail. It shows by survey stations the position of the 10 former grade crossings where the new bridges have been built, and their position with reference to each other and to passenger stations. The crossings are numbered consecutively, Nos. 1 to 11 inclusive. At No. 6, Copley Way, a new highway was located where there had been none previously, and a bridge built over the tracks as a substitute for Walnut street, abandoned.

On the main line the plan followed was to have two main tracks for use as a double track for regular traffic at all times during prosecution of the work. In the first temporary position the two tracks were laid on the original low grade, as near the west property line as practicable. The east part of the location land width was then available for the construction first of one track at the new elevated grade; then for the widening of the elevated roadbed for a second track; for the building of one-half length of each of the two masonry bridge abutments for each bridge over the highways and for the placing of the steel work of bridges for two tracks on such abutments. The bridges being plate girders in all cases, the other half of each bridge could be added later with economy and convenience. The steel bridge work on the main line was erected on the lines of tracks, which did not have regular traffic on them at the time of erection, an advantage of no mean importance as regards the cost of the bridge.

With two tracks so available on the new high grade, regular main line traffic was turned upon them, and the two tracks in the first temporary position on the low grade were abandoned with the exception of part to be mentioned hereafter, track material removed, and filling, masonry and bridge work was then built out and widened at high grade on the west side for two additional tracks, so completing the work for a four track permanent roadbed for the entire distance from Savin Hill to Neponset.

On the Shawmut branch, during prosecution of the work, regular traffic in both directions was handled over a single track from Harrison Square to the crossover at the end of double track at Sta. 32. At the first temporary move, the northerly one of the two original tracks was continued in service at original low grade level. The southerly part of the land width was then available for the construction of concrete masonry retaining walls on the south side line where needed, for building the south half length of each masonry abutment and for building a timber trestle to support one track at the new high grade for considerable lengths, where the land width of location was too narrow to allow earth filling to be made at first.

After transfer of traffic on the main line to the two high level tracks in the second temporary position, and the abandonment of the part of the two main line first temporary tracks, Harrison Square to Neponset, the one high level temporary trestle track on the branch was extended to a connection with the second temporary set of main line tracks. The E. D. T. crossover at Sta. 32 was then reversed, the branch line traffic turned over the one high level branch track and the north part of the location land width was then available for the construction of masonry abutments and retaining walls on property lines, after the removal of the first low grade track.

Construction conditions on the branch and at the junction made it necessary to continue the branch traffic on the one low grade track for some time after the main line traffic had been turned to the first high grade temporary main line tracks, and for this reason the branch traffic was necessarily handled in both directions over low grade tracks on the main line, located between Savin Hill and Harrison Square. This made necessary the maintenance for some time of a junction at Savin Hill, with regular signal protection, while the main line trains were being operated on the two high grade tracks in the second temporary position.

The Shawmut branch extends from Harrison Square 4.17 miles to Mattapan, the terminus of a branch, 7.81 miles out from Boston. It passes through a residential part of the Dorchester District and has passenger traffic only, with frequent suburban trains in and out of Boston, for the part we are now interested in. The land width is but 30 ft. on parts of the branch where the work was performed, and this narrow width was adjoining Dorchester avenue grade crossing, the one which had the greatest volume of street traffic of all those which were eliminated. In the avenue there were two electric street railway tracks

operated by overhead trolley. The street cars passed very frequently and the crossing frogs and trolley wires were kept in efficient working condition at all times.

On the south line of the 30-ft. land width of the railroad, a concrete masonry retaining wall was built, as the land adjoining was high-priced, and closely built over, making it uneconomical to purchase land for widening the right of way, and impossible to occupy it temporarily during construction. It was necessary to have niches in the back side of the south side retaining wall to receive the bents of the temporary trestle which supported the track at the high grade in order to leave sufficient clearance for train movements on the single track on the original low level. This temporary trestle on the branch was built at the places where conditions prevented the making of earth embankments at first. The part built with bents in niches in the retaining wall masonry on the branch was 197 ft. long from Sta. 17 + 45 to Sta. 19 + 42, and this trestle extended southerly past Field's Corner station 558 ft. more to Sta. 25 and northerly to and across Adams street. A temporary trestle was also built 385 ft. long on the branch from the north side of Clayton street, past Harrison Square station to Station 1, where it joined the main line temporary trestle.

It was practicable to build an earth fill for the branch up to the high grade between Clayton street and Adams street. The single track temporary high grade trestle on the main line was about 1,100 ft. long, extending from the south abutment of the new bridge for Freeport street, north, southerly to near Sta. 184. All of the temporary trestles were founded on the ground surface, it fortunately being hard enough to support the structures. At Freeman street the 8½-ft. cut was in solid rock. In this case the trestle was maintained in the usual way by changing the posts and using longer ones as fast as the excavation made it possible until the grade was reached.

Concrete masonry was used for all retaining walls, foundations and bridge abutments. All of the railroad bridges were of steel plate girders, with steel columns on the sidewalk lines for the greater number of them, with standard bridge floors of squared dimension hard pine ties and guard timbers.

On the main line trains passed very frequently. As many as 133 first class or passenger trains and 9 second class or freight trains passed in each direction in each 24 hours over the part of the line between Savin Hill and Harrison Square. There were occasional extras. For the construction service there were employed as a maximum number, for quite a long time:—One train and crew for shifting and delivery of material to contractors; one train and crew for extra gang on track work; and three gravel trains and crews steadily employed for a large part of the time 10 hours per day hauling gravel for filling from the steam shovel in Holbrook pit, 11.5 miles from Harrison Square. Two of these gravel trains were double crewed for night work for a term of about three months, when the conditions afforded the best opportunity to make filling. About 611,000 cu. yds. of gravel for filling was hauled by train.

To control all gravel and construction trains, a traveling yard master was assigned to this work. It was his duty to be on the site, and not only control the movements of work trains, but to assign their work and see that all work trains were properly employed and also kept within safe limits. Engineers, contractors, supervisors and construction foremen explained their needs, and applied to the traveling yard master when they needed switching service from work trains.

Work trains when on main tracks were not allowed to interfere with the movement of any first class train. The result of this was that no work train was allowed upon the No. 2 or northbound track from 7 to 9 a. m., nor upon the No. 1 or southbound track from 4 to 6 p. m. These were the periods each day when trains to and from the city were most frequent. Work trains were given rights on the main tracks up to

the schedule time of second class trains, by faithful and proper protection with flags or lanterns according to the book of rules. The second class trains made all their movements at night; that is those southbound on No. 1 track during the late afternoon hours, and those northbound on No. 2 track during the early morning hours each day.

At the beginning of the work the rule was adopted to install and maintain a complete set of standard signals to govern train movements for all tracks used as main tracks, in each temporary location, as well as for permanent tracks and this rule was faithfully adhered to until completion. Manual interlocking signal plants were in service at Savin Hill, Harrison Square and Walnut street, Neponset, and all switches in tracks used for main line traffic, were protected, moved and controlled from the respective towers. For the final permanent signal work an electric automatic system of the latest approved kind was installed, the electric current for power being purchased from a local electric company.

On the Shawmut branch at the end of double track, Sta. 32, a mast with semaphore arm was placed opposite the clearance point and was interlocked with the switch. The switch was thrown by hand by switchmen working in three shifts in each 24 hours. The track circuits were always maintained. Automatic banner signals were in service between Harrison Square and Neponset. The blocks were short, none being as much as one mile. The blocks being short, the train intervals were also short, the train movements being governed by the signals, and the allowable rate of speed. It resulted in a headway possibly as short as one or two minutes between trains. It is pleasing to state that no train accident happened to any regularly scheduled train during the work. The work was in progress from August, 1909, to the fall of 1912.

The highways which were crossed at grade by any of the tracks, temporary or otherwise, were kept protected by the lawful safety appliances. The crossing signs and gates were maintained, and the latter operated for the full 24 hours each day. Whistling by the locomotive was not allowed within the city limits, therefore whistle posts were not maintained.

The former local freight yard at Harrison Square was necessarily abandoned, and as a substitute for it, a new freight yard was built at low grade on the west side of the tracks north of Freeport street North. Another freight yard was built on the east side of the tracks from Sta. 225 to Sta. 244.

At the passenger stations, proper platforms were always kept available for the use of patrons at all times. It was at times necessary to have temporary platforms at different stages of the work, notably at Field's Corner station. As it proved necessary to keep the platforms convenient and safe, temporary stairs and safety railings were erected, and necessary plank walks were laid. At all times, at all stations buildings were kept available for the convenience and shelter of patrons. While these buildings were not always up to the track grade elevations on which trains made their station stops, they were safely accessible and the time was not of long duration when any of them remained below grade.

In the progress of this work 10 highway crossings formerly at grade were eliminated, and 9 bridges for the railroad and one bridge for a highway over the railroad were built. All were steel plate girder bridges. In the case of the highway bridge over, the entire structure was built by contract. The steel work of the 9 railroad bridges was furnished and erected by contractors. The bridge floors, hard pine ties and guard timbers of standard dimensions were framed and placed by the railroad company's employees of the bridge department. In addition to the above, two masonry arch bridges of small span beneath tracks were built for waterways and also a subway for Harrison Square station and another at Neponset.

The general direction of all work trains, steam shovel track men and

laborers was under the roadmaster, who reported to the division engineer. The pay rolls for this labor, and account of time and cost of work trains, with the record of tools, material and supplies needed were prepared and kept in the division engineer's office. The work as a whole was under the direction of the construction engineer, his assistant engineer and field parties.

The foregoing description of work performed is offered by the committee as a fairly representative example of the way traffic should be cared for during the elimination of grade crossings and the erection of the necessary bridges. In this case it is seen that the grading of roadbed, laying of track and erection of signals are necessary parts of the undertaking as well as the erection of the bridges. All are so closely related that preparation for one is also necessary preparation for the other. It is sure to prove this way in all such undertakings. The Book of Rules in force for the operating and other departments, and rules for flagging, proved adequate for the safe performance of the work, after the proper layout and plan of the work had been arranged, and the necessary materials and equipment provided. It shows what result it is reasonable to expect to obtain, with two tracks available for regular traffic, from a construction as well as an operating standpoint. It also shows what degree of protection is needed to secure safety, under the conditions mentioned.

Fig. 1. A view looking north. Savin Hill station building on the left. The signal tower on the right. This shows premises at the north end of the grade change on the main line.

Fig. 2. The railroad bridge and abutments at Freeport Street north. This picture shows the type of girder bridge and arrangement of columns adopted for the majority of the railroad bridges. The view was taken after trains were first changed from low level to the first pair of high grade tracks. The cutting down of the street grade was then in progress on the south half width, leaving the other half width for public use. After the south half width of street had been finished and surfaced at its new grade, the north half was then also lowered.

Fig. 3. Looking north showing conditions before any work was begun at Harrison Square. The junction of main line and the Shawmut branch.

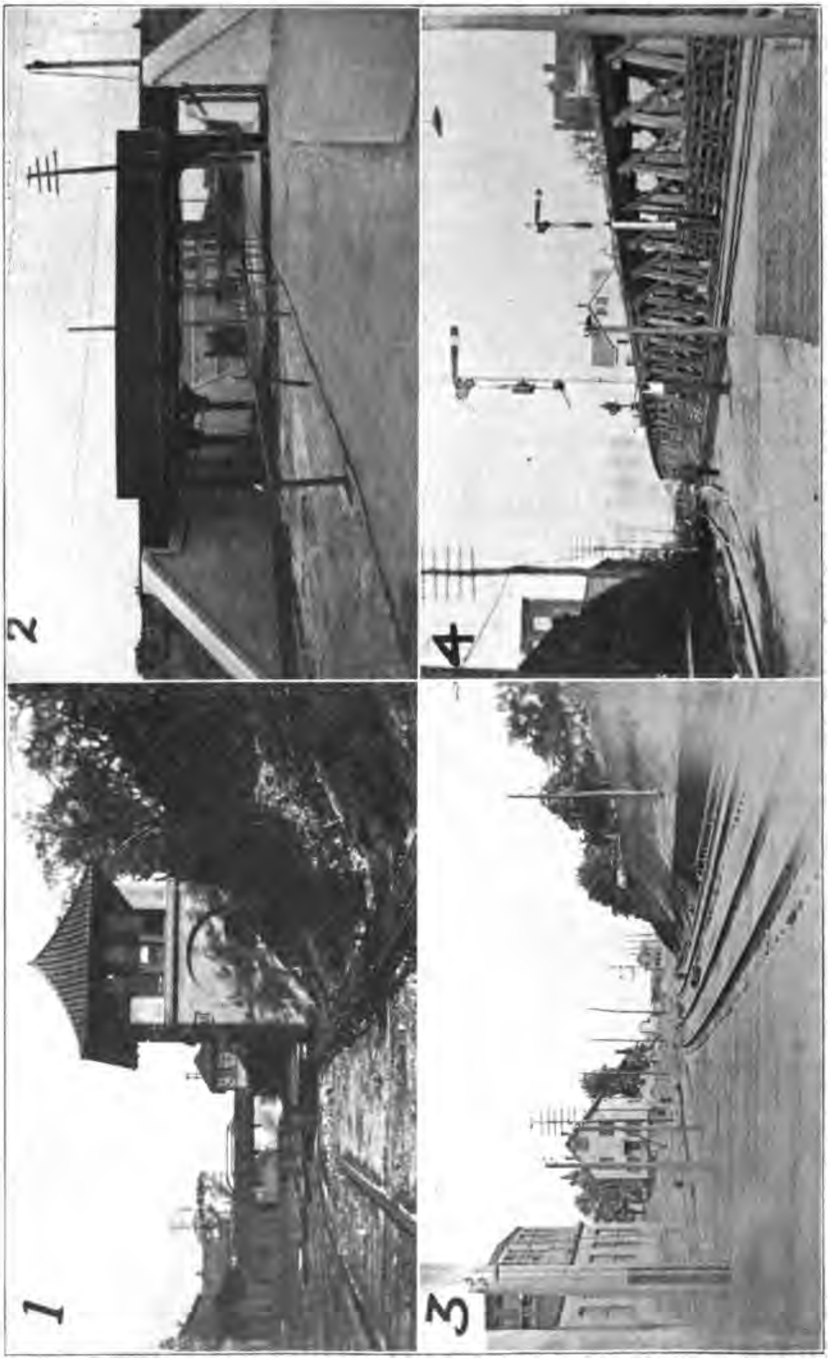
Fig. 4. Looking north with practically same view as in Fig. 3, when the first pair of temporary low level tracks had been laid on main line with trains operating over them, the temporary single track for the branch and the temporary main line trestle for one track at high grade. Note the tie crib built between the trestle bents to retain filling made from the east side of trestle and preserve clearance for the northbound low level main track. Note also the signals maintained for the main tracks in the first temporary position.

Fig. 5. Shows the original interlocking tower, a part of Harrison Square station building located between the Shawmut branch tracks in foreground and the main line track in the background. It shows also the east end of a former overhead foot bridge which was taken down. In the new work a subway was built in place of this foot bridge.

Fig. 6. A view looking north at Harrison Square, showing two main line tracks in first temporary position, the south end of the temporary trestle and the beginning of filling for high level main line roadbed for second temporary tracks.

Fig. 7. A view looking north from Harrison Square station platform shows the junction switch at high level in second temporary condition for tracks. Note the maintenance of signals. In the center the small temporary signal cabin from which the switches and signals were handled after original tower at Harrison Square had been abandoned. On the right note the forms for construction in concrete of the permanent signal tower when under construction.

Fig. 8. A view looking west showing on the left the Harrison

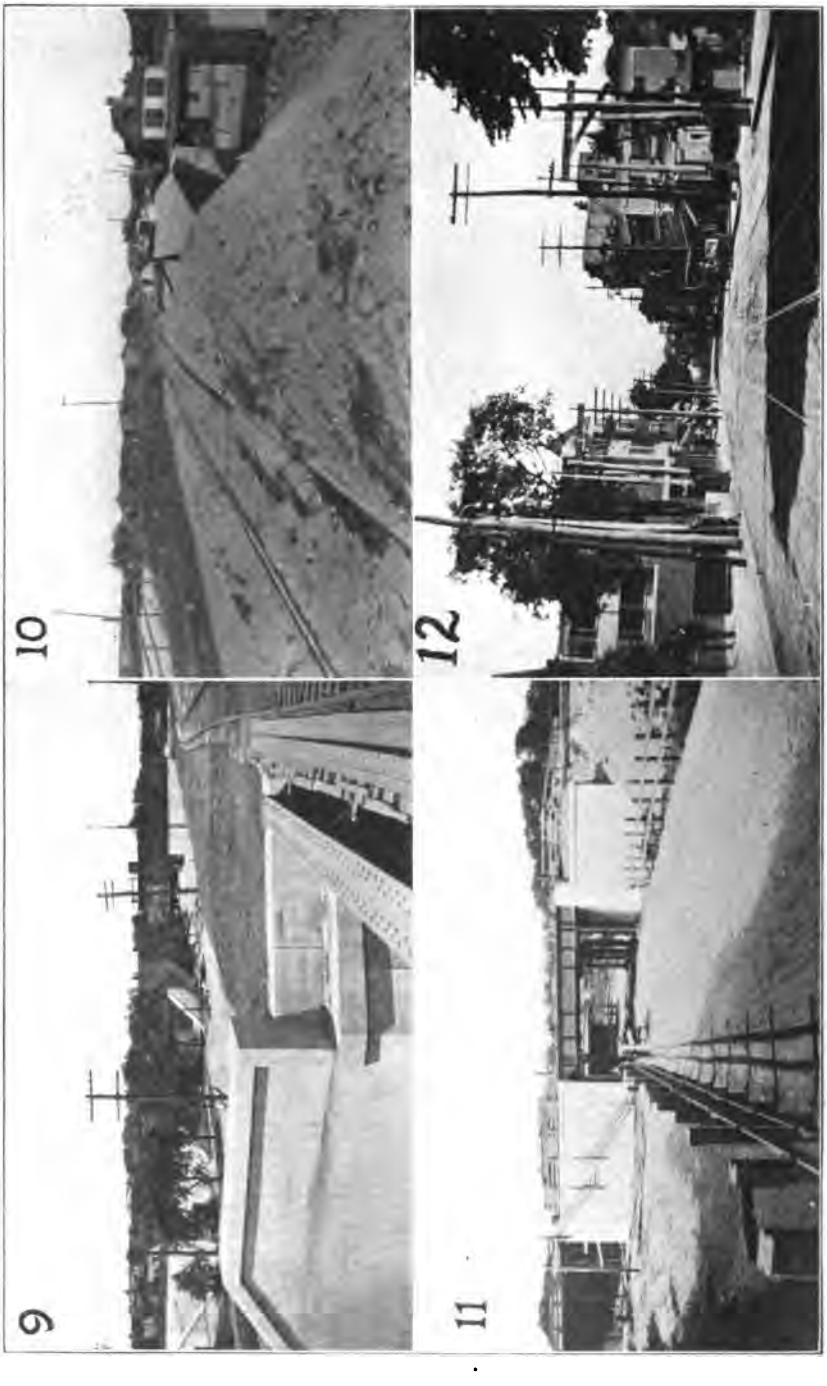

1
2
3
4


5


6


7


8


9
10
11
12

Square original tower just before it was torn down, with main line tracks on high level and masonry with stairs leading to the station platform. Note the end of the station subway temporarily boarded up. The west half length of the subway had not been built when this photograph was taken.

Fig. 9. A view looking northwest shows both the main line and branch at high grade. Park street bridge in the foreground before permanent tracks Nos. 1 and 3 had been laid across it. Clayton street bridge on the branch in the center soon after the new bridge had been

placed. Note the temporary stairway leading up to the temporary platform for Harrison Square station.

Fig. 10. A view of the main line looking south at Pope's Hill with the station building still at low level shortly before it was elevated. Note on the left center a temporary shelter shed, which preceded the erection of the permanent station building on the east side of tracks. The two main tracks in this view, serving temporarily as a double track, eventually became tracks Nos. 2 and 4 of the permanent four track roadbed. The dumping track in the foreground eventually became No. 1 of the permanent tracks. The masonry for the new bridge for Freeport street south shows in this picture.

Fig. 11. Looking west shows new bridge for Freeport street south. Note the permanent stairway for Pope's Hill station with temporary railings.

Fig. 12. A view of Dorchester avenue looking north under original conditions with the street railway tracks and trolley wires showing. The position of steam railroad tracks in the center with their cross frogs showing indistinctly is indicated by the crossing signs and crossing gates.

Fig. 13. Shows Dorchester avenue looking south, with the Shawmut branch temporary trestle to support trains at high level, and showing excavation in progress for lowering the grade of the avenue. Note that the street travel is concentrated on one-half the width of the avenue and that street railway travel in both directions is on one track.

Fig. 14. This view is looking east along track of the Shawmut branch from Field's Corner station. It shows the branch in a part where the land width is 30 ft. the narrowest width. The single track for traffic is in the second temporary position at high grade with the temporary trestle partly filled in and on the left the contractors' tramway track and car used for moving concrete for retaining walls from the mixer located under the derrick in the center. The concrete retaining wall is under construction beneath the tramway. The exposed face of the retaining wall is on the land line near the sides of the buildings on the left. The buildings are on the land of other owners. The Field's Corner temporary station platform with its safety railings shows on the right foreground.

W. F. Strouse, assistant engineer, Baltimore and Ohio, submitted the following discussion of the subject:

The accompanying plans show two pieces of work upon which we are now engaged which illustrate our method of handling work of this character.

Fig. "A" illustrates our method of carrying traffic over an opening in which we have built a 30-ft. concrete arch. We first drove piles as illustrated on this drawing except that at the points marked "B" we drove double bents, using five piles under each track in each bent. The tracks were carried in this manner until the excavating was done and the masonry was constructed to the elevation of the springing line on the arch. The double bents were then cut down as illustrated in Fig. "B" and plate girder spans of 64 and 66 ft. respectively were substituted for the purpose of carrying the traffic while building the arch proper. As soon as the masonry was finished, the space below the girders was backfilled with cinders and other suitable material to approximately the under side of the girders. Cinders were then dragged out upon the tracks, filling the space to approximately the base of the rails.

When the concrete was sufficiently hard, the girders were lifted out with wrecking cranes, one at each end, after which the track was restored and additional cinders added. Both girders were removed the same day, the traffic on each track being cut out for a period of about two hours.

Fig. "C" illustrates our general method of taking care of traffic while constructing abutments for supporting steel girders. The piles

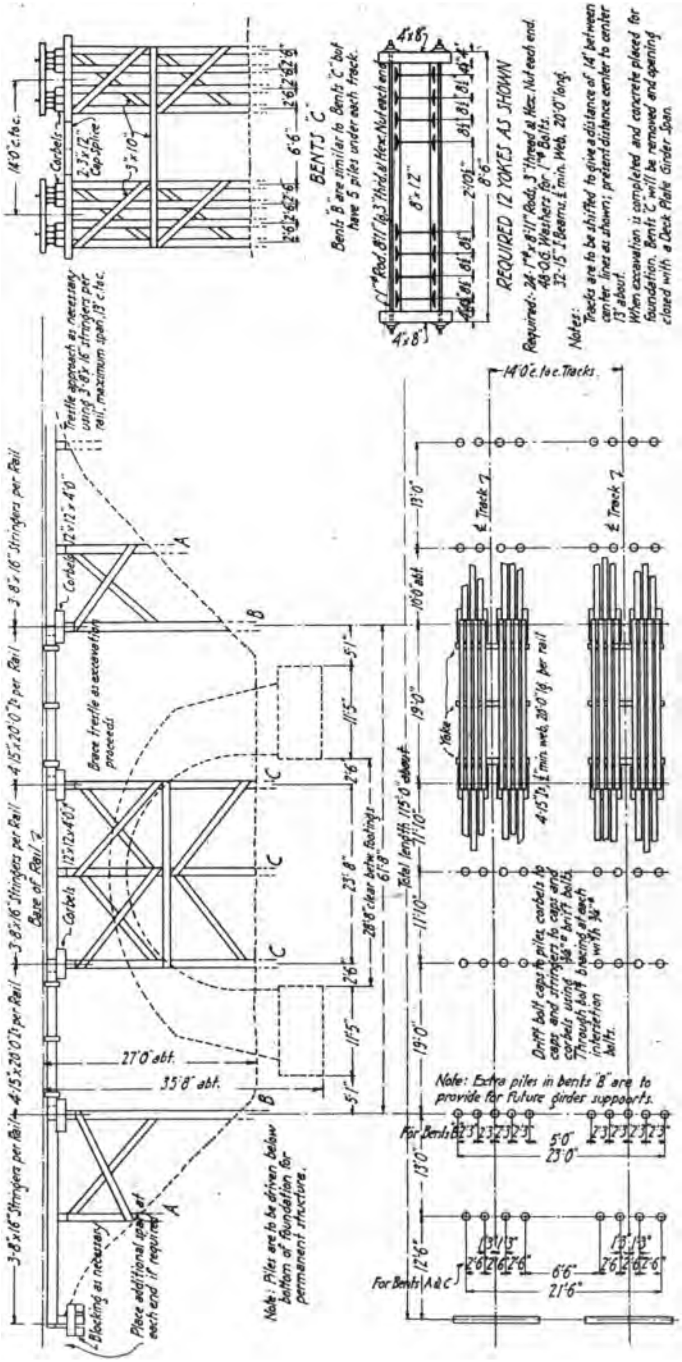


Fig. A. Temporary Structure, Elimination of Grade Crossings, B. & O. R. R.

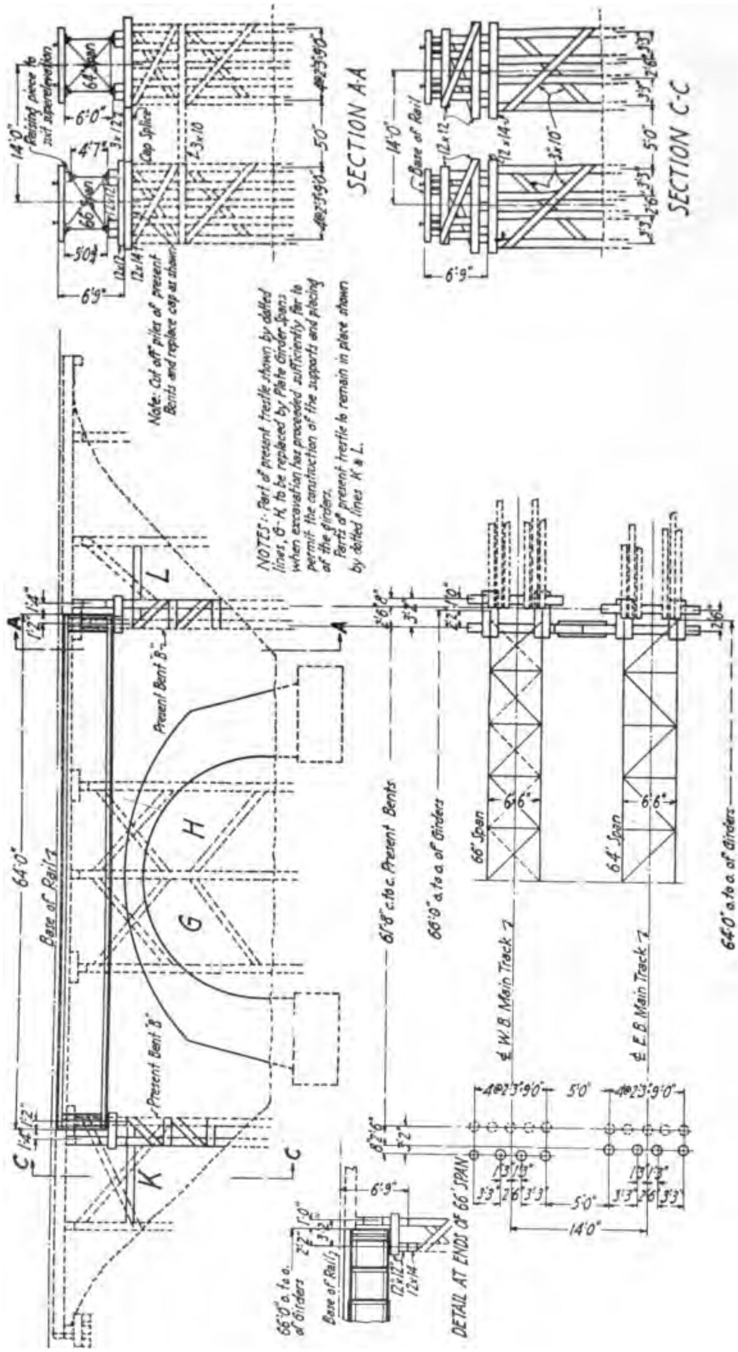


Fig. B. Temporary Structure, Elimination of Grade Crossings, B. & O. R. R.

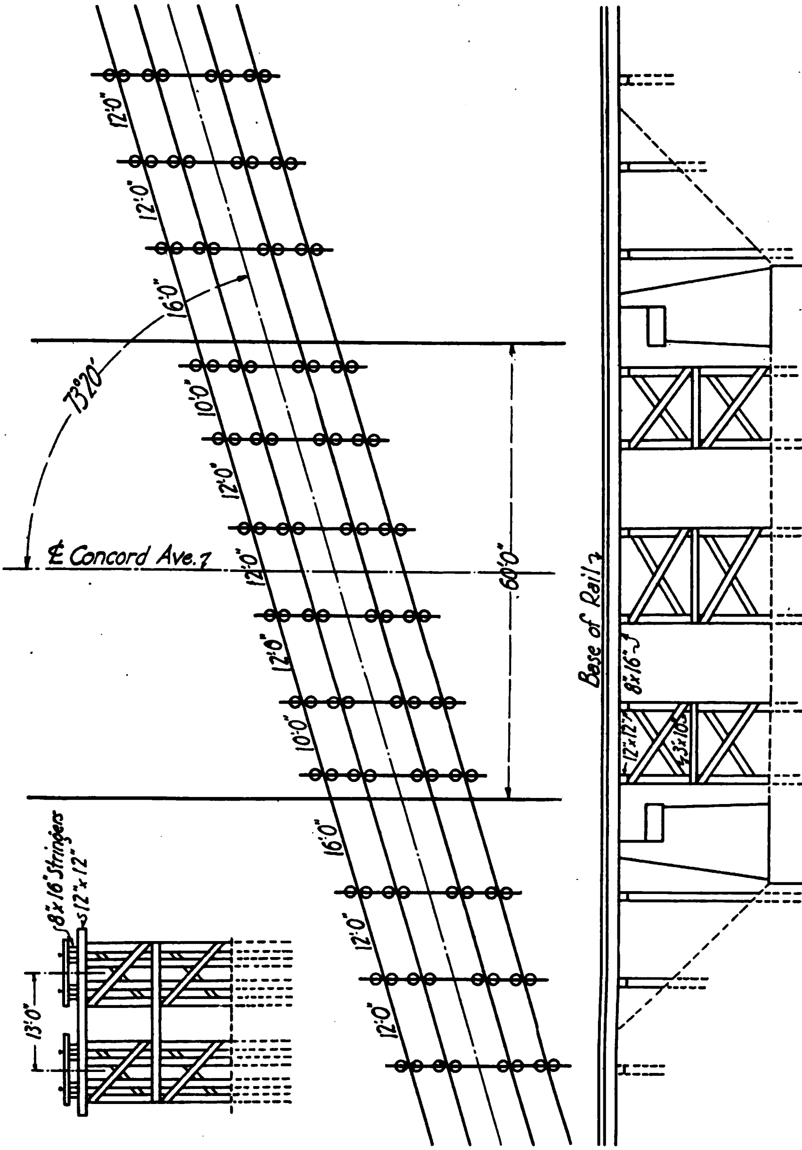


Fig. C. Temporary Structure, Elimination of Grade Crossings. B. & O. R. R.

were driven before any work was done, after which the street was depressed, bracing being applied as this work progressed. This method, of course, cannot be utilized where rock is encountered above the foundation lines. In cases of this kind we support the tracks by excavating trenches to the elevation of rock, placing timber bents with necessary stringers to carry traffic while removing the rock to a lower level. New timber bents are then placed before the removal of the other bents for the purpose of removing the rock under the same. This process is repeated until the material is removed to the proper elevation. Where possible, of course, we build detour lines to avoid the necessity of expensive trestle work.

G. T. Sampson, Chairman.
R. H. Reid,
J. P. Canty,
W. F. Strouse,
F. E. King,
W. H. Wilkinson,
E. U. Smith,
E. N. Layfield,
Committee.

Subject No. 8.

WATER PIPE.

REPORT OF COMMITTEE.

1. Historical.
2. Cast Iron Pipe.
3. Cost of laying cast iron pipe.
4. Table of friction in pipe.
5. Table of friction in elbows.
6. Wood pipe.
7. Wrought iron pipe.
8. Pipe joints.
9. Leaks and repairs.
10. Soil conditions.
11. Incrustation.
12. Electrolysis.
13. Water Hammer.
14. General.

In preparing this paper it is realized that it would not be practical, or appropriate to attempt a discussion of each of the many different types of water pipe in general use today. Such a discussion would take up a great deal of time and space and would contain much that would be of very little interest in railway water service. The intent has been to confine the matter as closely as possible to such water pipe as is in general use in railway service.

Historical.

The first application of a pipe or tube for carrying water is lost in antiquity, but undoubtedly some sort of pipe has played its part in every age of man's struggle for existence. Probably the giant cane, or bamboo, which grows to a diameter of four to six inches and forms a natural tube, with very little labor, answered for the first pipe line ever constructed by man. The earliest known pipes were earthen, or pottery tubes, and stone pipe cut from solid blocks. The earthen pipes were sometimes encased with blocks of stone cut to surround the pipe and the joints were filled with mortar to secure greater strength. Some of the stone pipe was fitted with a sort of hub and spigot and the joint made with cement. Iron clamps were also used to add to the strength of the pipe.

"Probably the oldest known pile line still to be seen is that which supplied a part of Jerusalem's water supply in Solomon's time (about 1000 B. C.). This pipe line was constructed of earthen pipes about 10 in. in diameter and was about 12 miles long. It brought water from reservoirs near Bethlehem, known as the pools of Solomon, and terminated just west of the temple."* The ancient Romans were perhaps the first to make pipes from metal for carrying water, but about the only material they had was lead and it was too expensive for general use. The Roman pipes were of a piriform shape and the joints were made with

*Edw. Wegman, Am. W. W. Assn. 1912.

melted lead. Wood pipe was finally substituted for the lead pipes in Rome, and for centuries it was relied upon almost entirely for water mains.

The first water supply of the City of London had lead and wood mains, the wood finally supplanting the lead pipes. The first public water supply in America was constructed in Boston in 1652. The mains were of wood and were taken up and replaced with wood again in the latter part of the 17th century.

The Cast Iron Water Pipe Bureau gives the record of the first installation of cast iron pipe at Versailles, France, in 1664. This pipe is still in use after 250 years of service. This is given as the earliest application of cast iron pipe of which continuous service records are available. The first wrought iron pipe was used in this country in the early part of the 19th century. Previous to this time the welding of wrought iron pipe was done by hand and was a slow and expensive process. The manufacture of steel pipe has been confined to the last 20 to 25 years. A quarter of a century ago not over 5 per cent of the pipe was steel, yet 85 per cent of the welded pipe made today is steel pipe.

Cast Iron Pipe.

Cast iron pipe is preferable to either wrought iron or steel pipe for underground water mains, because of its greater resistance to corrosion. Being one-half to one-third the thickness of cast iron pipe wrought iron or steel pipe will show the ultimate effects of corrosion in a correspondingly less time at the same rate of corrosion. Aside from this, cast iron pipe from its chemical composition being next of kin to the ore itself which has lain in the ground for hundreds of years can be expected to last longer than any other pipe. Some authorities claim that the silicious coating, or glaze, formed on the iron from contact with the sand while casting, offers an additional resistance to corrosion.

There is considerable data on the life of cast iron pipe which goes to show that it is good for 100 years when properly coated, under almost any soil conditions. The cast iron intake for the City of Paris, which supplied the first pumping station in Paris, and which was laid in 1802, was recently removed and after over a century was found in fairly good condition and could have been used again. In this country cast iron pipe laid in New York City in 1833 is still in service. Leading authorities agree on a life of 75 to 100 years for cast iron pipe and the conclusion may be drawn that beyond question cast iron pipe is best fitted for underground mains.

Approximate Cost of Laying Cast Iron Pipe.

The cost of pipe laying will vary greatly owing to local conditions, cost of labor, etc., but the following table gives the approximate cost as determined by actual railroad practice. (Cost per Lineal Foot of Pipe Laid.)

Table 1.

Diameter of pipe,	4 in.	6 in.	8 in.	10 in.	12 in.	14 in.
Pipe @ $30 per ton,	$0.36	$0.54	$0.78	$1.06	$1.38	$1.53
Yarn @ 7c per lb.,	.0012	.002	.003	.0035	.004	.005
Lead @ 5c per lb.,	.031	.0425	.05	.07	.08	.09
Loading and handling,	.01	.015	.02	.025	.03	.04
Trenching & refilling (4 ft. cover),	.14	.15	.16	.18	.20	.22
Laying, caulking, etc.,	.05	.07	.10	.12	.15	.17
Total per lin. ft.,	$0.59	$0.82	$1.11	$1.46	$1.84	$2.06

The above figures are based upon class "C" pipe for a 300 ft. head and 130 lbs. pressure, with the exception of 14 in. pipe which is based on class "B" pipe for a 200 ft. head, and 86 lbs. pressure. Fourteen inch pipe is usually installed only for penstock lines with a comparatively low head.

Table 2.

Cost of Laying Cast Iron Water Pipe, Iowa Division, C. & N. W. Ry.

Material						
Diameter of pipe,	4 in.	6 in.	8 in.	10 in.	12 in.	14 in.
Weight per lin. ft., lbs.,	22	34	47	64	82	103
Lead per joint, lbs.,	9	10	13	15	20	23
Jute per joint, lbs.,	0.5	0.75	0.75	1.0	1.0	1.25
Total cost of material, lin. ft.,	$0.38	$0.60	$0.68	$1.10	$1.45	$1.65
Labor						
Excavation, per lin. ft.,	$0.23	$0.27	$0.32	$0.35	$0.40	$0.48
Backfilling, per lin. ft.,	0.04	0.04	0.04	0.05	0.05	0.06
Jointing, per lin. ft.,	0.03	0.04	0.04	0.05	0.05	0.06
Total cost of labor, lin. ft.,	0.30	0.35	0.40	0.45	0.50	0.60
Total cost material and labor per lin. ft.,	$0.68	$0.95	$1.08	$1.55	$1.95	$2.25

Notes: Ditches average 2½ ft. wide and 5 ft. deep. Earth chiefly clay sufficiently stiff to stand. Braces used more or less. No curbing and very little trouble on account of water. Wages, laborers 20 to 22½c; caulkers, 25c; foreman 30c to 32½c per hour, with 5 per cent added for superintendence and accounting. Price of material includes special fittings and valves. Average depth of lead joints, 1¾ in. to 2 in.

Pipe Joints.

Lead Joints:—The ordinary poured lead joint for cast iron pipe is so well known that it scarcely requires a description. Making a joint of this kind is very similar to packing a stuffing box, and quite as important. The placing of hemp or jute in the joint space between the spigot and the bell is perhaps the most important operation in making a joint of this kind. The packing should be twisted to form a rope a trifle larger than the joint space, and cut so that the ends will meet when driven home. Care should be taken that the packing is driven up evenly so that a uniform lead space is left. This lead space is about one-third of the length of the bell for ordinary service, and either plain or tarred jute may be used. Tarred jute has the advantage that it can be driven tighter than plain packing, but as the tarred packing is much harder to handle the plain packing is usually given preference. After properly yarning the joint, the lead roll is placed around the pipe for pouring. Care should be taken that the roll fits firmly against the hub to avoid leakage of the lead as the pouring of the joint should be continuous until the joint is filled to secure the best results. A break in the pouring to stop a leak usually leaves a seam in the joint where the lead has cooled so that it is never as good a joint as one continuously poured until it is full. The bottom of the joint should be caulked first, working up each side of the pipe, leaving the top for the last. The joint should be driven up until the caulking tool rebounds slightly from the lead.

Cement Joints:—A cement joint for water pipe is much cheaper than the lead joint and more rigid. Being perfectly rigid a pipe laid with cement joints will not come and go as with lead joints and excessive expansion and contraction, vibration, or settling. Settling of the pipe will cause a fracture of the pipe, and for that reason it could not be recommended for general use. A cement joint should be made by using neat Portland cement. The joint should be made by driving a roll of dry jute tightly to the bottom of the bell and then filling evenly with cement to a point about half the depth of the bell and another roll of jute driven against the cement until the moisture shows on the jute. The bell should then be filled evenly with cement to the face of the hub. The cement should be as dry as possible and should be used immediately after mixing. Considerable practice is necessary before the cement joint may be made successfully.

Leadite:—Leadite is a composition in the form of a black powder. the base of which is sulphur. It melts at a temperature of about 240 deg. F., and is used in the same manner as in making a lead joint with the exception that no caulking is required. Greater care is required in

handling leadite than lead, as at too high a temperature it thickens so that it cannot be run into a joint. Also the sulphur will ignite if allowed to get too hot. The advantage in leadite is that it is about 25 to 30 per cent cheaper than lead, but the greatest care is necessary to insure a good joint, and once poured it cannot be caulked as with a lead joint. A small leak in a leadite joint will soon take up through rust as part of the composition is iron.

Lead Wool:—Lead wool is used in the same manner as jute and is useful in water and where it would not be convenient to pour a joint. It is also useful in making repairs to leaking or blown out lead joints. In many cases it avoids necessity of cutting out the old joint and running a new one. The cost of lead wool joints is about 25 per cent more than joints made with pig lead.

Rust Joints:—A rust joint for cast iron pipe may be made of the following composition:

80 parts fine iron chips
2 parts sal ammoniac
18 parts water

This joint is made in the same manner as the cement joint except that only one thickness of the iron cement is used. After hardening this joint is practically as solid as the pipe itself. The rust joint is seldom used today, but in former years was used for low pressure cast iron steam and hot water lines.

Wood Pipe.

Wood pipe has been used for centuries past as a means of conveying water. The water supplies were dependent on wood pipe long before cast iron pipe was made. The first water supply of London, Boston, Philadelphia and New York had wood pipe for distribution systems. Much of the data collected on wood pipe pertains to the old "pump log," or solid wood pipe. The first wood pipe logs were bored to the desired size and often the bark was left on the log. Others were turned and wrought iron bands applied, and then coated with pitch or tar. The modern wood pipe is constructed of staves, machined to a circle and held together with a flat soft steel band wound spirally around the pipe, the finished pipe being coated with asphalt and rolled in sawdust or wood shavings. The rapid development of the wood stave pipe was in the Pacific Coast States. Here there was a great demand for public water supplies and the cost of transportation of cast iron pipe was so great that the expense was almost prohibitive. With an abundance of suitable timber close at hand the result was that factories were established for making the wood stave pipe. There is no question but that wood stave pipe has its place among the standard types of pipe, but at the same time there are many installations where cast iron pipe would have answered the purpose better. Where the pressure is constant, or where the water is highly charged with acids, wood stave pipe should give satisfaction.

Specifications for Wood Stave Pipe.

Character of pipe:—This pipe shall be made of wood staves cut from the best obtainable quality of white pine, fir, or cypress.

Lumber:—All staves shall be free from loose, black, unsound knots or large knots passing entirely through the stave. They shall also be free from checks, shakes, or splits and have a dressed thickness of 1⅞ in. All lumber shall be sound and thoroughly seasoned before being worked up into staves. All staves shall be accurately cut to the circle of the pipe, shall be perfectly smooth on the inside and shall have a double tongue and groove on the edges.

Joints:—The joints shall be mortise and tenon joints, cut out of the full thickness of stave after the pipe sections are properly put together

and wound with the steel bands hereinafter specified. The outside diameter of the tenon shall be cut slightly larger than the inside diameter of the mortise in order that a tight joint may be secured.

Steel hoops:—All pipe shall be wound with the best quality of mild steel hoop, having a tensile strength of between 58,000 and 65,000 lbs. per sq. in., and an elastic limit half as great as that of the breaking strength. All steel hoops shall be free from rust and loose scale as it is wound onto the pipe. It shall come from the mills and be applied to the pipe free of all physical damage, such as crimps or any distortions that would in any way injure or rupture the steel.

The width of the hoop shall be 1 in. or 1½ in., and the gage shall be No. 14 of the Birmingham or English gage for a 1 in. hoop, and No. 18 for a 1½ in. hoop.

The binding shall be tightly wound onto the pipe under heavy tension, and it shall be uniformly spaced throughout the length of the pipe. The sectional area of the band and spacing shall be such that the working strength in the steel shall be limited to 15,000 lbs. per sq. in. for the water pressure specified for the pipe being wound.

In beginning the winding of the pipe, sections of steel bands shall be securely fastened about six inches from the end of the pipe. The bands shall be then spirally wound back to the end of the pipe and shall then return, spaced as above specified for the full length of the pipe. When the opposite end of the pipe is reached on this spacing the winding shall be returned for a distance of six inches and the end of the band shall be securely fastened to the stave by two galvanized screw nails, as long as the thickness of the stave will permit without penetrating into the inside of the pipe, all in accordance with the standard winding of the pipe herein specified.

All pipe shall be thoroughly coated with a double coating of the best grade of asphaltum mixed with sawdust. The pipe shall first receive a heavy coat of asphaltum by proper turning on the asphaltum roll. It shall then be rolled on the sawdust table, and finally the coating shall be completed by proper rolling on the dry finishing roll, whereby the mixture of asphaltum and sawdust shall be rolled down to a hard, dense and uniform coat and surface. This coating shall then be carefully trimmed off at the pipe end so as not to interfere in any manner with the pipe joints and the proper driving of the pipe in the trench.

All mortises and tenons of the joints shall be painted with a thin preservative coating of coal tar residuum mixture to preserve those parts from checking.

Workmanship:—All workmanship shall be thoroughly first class and the pipe staves, joints and all parts of the pipe shall be carefully cut to precise dimensions, in order that water tightness under the specified pressure may be secured and such water tightness shall be secured and shown by such tests from time to time of properly saturated pipe.

Extra asphaltum:—The manufacturers shall ship sufficient asphaltum with the pipe to properly re-coat any breaks that may occur in the coating on account of shipment.

Wrought Iron Pipe.

The term wrought iron pipe, as generally used, designates both wrought iron and steel pipe, while as a matter of fact there is a wide distinction between the two classes of pipe. There are also several different grades of steel pipe, though it is difficult to distinguish between them except by analysis.

Genuine wrought iron pipe is rarely furnished unless so specified and purchased on analysis. The advantage of genuine wrought iron pipe is chiefly in its greater resistance to corrosion, though it will be found

more satisfactory to handle as it will cut and thread more easily than steel pipe. The cost of the genuine wrought iron pipe is about 20 per cent more than steel. In a great many instances, the cost of conduits, covering, carriers and labor installing represents such an expenditure that the pipe itself represents a comparatively small portion of the total cost and when the longer life of the wrought iron pipe is given consideration its use would appear to be justified regardless of the first cost. One of the most severe usages to which wrought iron or steel pipe may be put is roundhouse service, either for overhead steam, water, or air lines, or for heater pipes in pits since the coal gases quickly attack the overhead lines and the moisture works havoc with the pipe in pits. Wrought iron pipe will easily last 50 per cent longer under these conditions.

Steel pipe has greater strength than wrought iron pipe and where the pipe is not subject to excessive corrosion common merchantable steel pipe will answer for general service above ground, but wrought iron pipe is preferable for underground work, or where it is subject to deterioration from the effects of corrosion. A cheap and effective method of protecting pipe laid underground is to coat it with asphaltum or pitch and wrap it with burlap. In protecting pipe in this manner, the burlap should be applied as the pipe is laid and particular attention should be given the exposed threads back of the coupling. Where the water is used for drinking or other sanitary purposes galvanized or tin lined pipe should be used as certain waters are affected by contact with iron pipe.

Suction lines for pumps are subject to more or less vibration and the importance of keeping such lines tight necessitates the use of a threaded pipe, which should be wrought iron in preference to steel. Steel well casing is subject to rapid decay and the increased life of wrought iron pipe will justify its use for this purpose. Aside from suction lines and well casing the use of either steel or wrought iron pipe larger than three inches would not be justified for underground service.

Specifications for Wrought Iron Pipe, Illinois Central R. R.

1. Wrought iron pipe must conform to the following table for outside diameter, thickness, weight and number of threads:

Size of Pipe	Outside Diameter	Thickness	Wgt. Per Foot	No. of Threads
1/8 in.	.405 in.	.068 in.	.24 lbs.	27
1/4 "	.540 "	.088 "	.42 "	18
3/8 "	.675 "	.091 "	.56 "	18
1/2 "	.840 "	.109 "	.84 "	14
3/4 "	1.05 "	.113 "	1.12 "	14
1 "	1.31 "	.134 "	1.67 "	11 1/2
1 1/4 "	1.66 "	.140 "	2.24 "	11 1/2
1 1/2 "	1.90 "	.145 "	2.68 "	11 1/2
2 "	2.37 "	.154 "	3.61 "	11 1/2
2 1/2 "	2.87 "	.204 "	5.74 "	8

Any piece of pipe in the lot must not be more than .02 in. smaller in outside diameter, nor more than .01 in. less in thickness, nor more than 2 1/2 per cent less in weight than specified.

2. The threads must be Briggs standard as determined by Pratt & Whitney gages.

3. The weld must be perfect throughout. Sizes 2 in. and over must be lap welded, with weld not less than 5-16 in. long.

4. Pipe must bend hot and cold 180 deg. without crack or opening at the weld, over a mandrel of diameter specified below:

	Diameter of Mandrel	
Size of Pipe	Hot Bend	Cold Bend
1/8 in.	1 in.	2½ in.
¼ "	1⅛ "	4 "
⅜ "	1½ "	6 "
½ "	1¾ "	8 "
¾ "	2¼ "	11 "
1 "	2¾ "	17 "
1¼ "	4½ "	26 "
1½ "	6 "	34 "
2 "	9 "	
2½ "	12 "	

5. Pipe failing to meet the above or any of the following requirements will be rejected:—

(a) Total carbon—not over 0.1 per cent.
(b) Manganese—not over 0.2 per cent.
(c) If material does not show a characteristic pure iron etch.
(d) If material does not show a fracture wholly fibrous.

The foregoing specification was prepared chiefly to cover pipe for steam and air lines, and while it would answer for a good commercial grade of pipe for general service of this kind, there is a question as to whether genuine wrought iron pipe would be furnished. Where the pipe is specified as wrought iron pipe it would be understood by any of the distributors of pipe that steel pipe was wanted. It is hardly necessary to give the analysis in ordering pipe, but where genuine iron pipe is wanted, it is necessary to specify "Full Weight Genuine Wrought Iron Pipe," in which case you may be assured that steel pipe will not be furnished.

Genuine wrought iron pipe should be made from puddled pig iron unmixed with scrap of any kind. No scrap other than the ends of pipe should be allowed in the pile, the pipe should be thoroughly welded together into a homogeneous mass and rolled into skelp, free from blisters, patches of cinders or unrefined iron. The tensile strength of genuine wrought iron should not be less than 40,000 lbs. and not more than 48,000 lbs. and an elastic limit of not less than 22,000 lbs. and not more than 30,000 lbs. per sq. in. The pipe should stand a hydrostatic test of 750 lbs. for pipe 2 in. and under and 1,000 lbs. from 2 in. to 8 in. A broken piece of genuine wrought iron pipe should not show a short or crystalline break, but should show a fibrous formation. It should be straight, tough, fibrous and uniform in quality throughout, free from cinder pockets, blisters, burns, etc., and an analysis should show the following: Carbon, .05; manganese, .05; phosphorus, .25; sulphur, .20.

Soil Conditions.

In laying underground water pipe it is necessary to take into consideration the soil conditions as affecting the life of the pipe as well as the quality of the pipe itself. It is a well known fact that clay forms the best possible covering for underground pipe, while cinders are the worst. When laying pipe through cinders, flooring the ditch with clay for a foundation and covering the pipe until it is surrounded with the clay will form an effective protection at a very small expense. It is not always possible to find favorable soil conditions but in many cases slight changes in the location of pipe lines will double the life of the pipe through laying it in a better soil. In preparing the trench the bottom should be uniform so that the joints will not be cramped. Cramped joints are difficult to make up and fill with yarn and are responsible for

a large percentage of joint leaks. Pipe laid along the right of way or near tracks should be as far from the tracks as possible on account of the effect of vibration from passing trains, and the possibility of track changes throwing the pipe under the tracks. The trench should be deep enough to permit laying the pipe below the frost line. The frost line will often vary within a few hundred feet depending on the exposure of the ground. The soil conditions will have a bearing on the depth of frost. A pipe will freeze more readily in sand or cinders than in clay and frost will penetrate wet soil deeper than dry soil.

Leaks and Their Causes.

As a chain is no stronger than its weakest link, so a pipe line is largely dependent on the joints for strength. Aside from the question of strength a poor joint may cause a heavy loss through waste of water. These underground leaks are not always easy to detect, for there is nothing in the old saying that "leaks will always show at the surface." Where the pipe is laid in sand, cinders, porous earth or in close proximity to sewers it may leak for years without any indication of the leak appearing on the surface. The presence of leaks of this kind may sometimes be determined by comparing carefully the consumption with the pumpage, or with meter readings, but locating and repairing the leak is often such a difficult matter that one sometimes wonders whether it is cheaper to permit the pipe to leak or to make repairs. However, this question answers itself; it always pays to stop leaks.

All leaks in water mains may be found under one of the following causes: Settling of the pipe; expansion and contraction; deterioration through corrosion; electrolysis; or poor joints.

As a general thing little trouble will be experienced from settling unless pipe is laid in new-made fill or very soft ground. Whenever it is possible to avoid it, pipe should never be laid in a new fill until the fill has had time to settle thoroughly. Pipe laid in a new fill at a mechanical terminal of a western railroad with a 4 ft. cover was 8 ft. deep when the fill had settled properly and the cost of repairs exceeded the cost of laying, while the waste of water while repairs were being made would have paid for the laying a second time.

Where pipe is laid through very soft soil, the ditch should be well floored or piling driven. Very little trouble will be experienced with the underground mains from expansion or contraction where cold water is used, but where hot and cold water are alternately pumped through the line as is the case at some mechanical terminals, trouble from leaks due to the expansion and contraction of the pipe is unavoidable.

Where mains are laid under or near tracks, there is often considerable trouble from leakage. Mains passing under tracks should be buried the maximum depth and as few joints as possible placed immediately under the track. This trouble may sometimes be eliminated by "bridging" over the pipe with heavy timbers laid parallel with the pipe to support the ties and take the shock of passing trains off the pipe. Leakage from corrosion in a cast iron pipe is very remote and is hardly worth considering except that caused by electrolysis, discussed elsewhere in this report.

The principal cause of leaks is poor joints. The proper attention to pipe joints will always pay; too often a small leak is trusted to "make up," but in the majority of cases it continues to "leak up." The only safe course is to stop the leak and stop it now! Wherever possible joints should be tested to the maximum pressure before being covered up. This practice will sometimes save a great deal of trouble afterward.

Incrustation.

Incrustations and deposits in water pipe seriously affect the carrying capacity of the pipe, and by increasing the friction very materially increase the cost of pumping. The frictional loss in dirty water mains

is far in excess of the actual reduction in area due to the roughness of the pipe. As a matter of fact, the interior coating of new pipe may affect the carrying capacity as much as 20 per cent due to the care and smoothness with which it is applied. The effect of surface roughness may be illustrated by the fact that the bottom of a ship covered with barnacles to a thickness of ⅜ in. has to be thoroughly scraped on account of the rough surface creating so much friction that the speed is greatly retarded.

In 1913 an 8 in. water main, supplying water from the Big Muddy river to the Illinois Central at Carbondale, Ill., became so badly incrusted that it was found necessary to have the main cleaned. The pressure before cleaning was 140 lbs. delivering 400 gal. per min., which indicated that the pipe was reduced to approximately the capacity of a 5 in. pipe. Upon examination it was found that the diameter was reduced to about 7 in. The pipe was cleaned under contract by a water-main cleaning company. The contractor guaranteed to restore the pipe to within 95 per cent of the carrying capacity of new pipe. The deposit removed from the pipe was about 16 tons and the work was done without taking the station out of service, and without any delays to trains. The line consisted of 11,554 ft. of 8 in. pipe and 5,000 ft. of 12 in. pipe with five 8 in. 90 deg. elbows, the static discharge head being 78 ft. The theoretical pumping head on a delivery of 500 gal. per min. is as follows:

Friction on 11,554 ft. of 8 in. pipe, ...	29.00
Friction on 5,000 ft. 12 in. pipe, ...	2.00
Friction on five 8 in., 90 deg. elbows, ...	2.90
78 ft. head, ...	33.80
Total theoretical head 500 gal per min., ...	67.70

After cleaning, the pressure required to deliver 498 gal. per min. was 70 lbs. Allowing 5 per cent for possible error or variation in meter, it will be seen that the contractor was within his guarantee of 95 per cent of the carrying capacity of new 8 in. pipe. In this instance the effect of cleaning was to reduce the pressure 50 per cent and increase the delivery of water 20 per cent. The saving effected amounts to $600 per annum in operation alone, to say nothing of the increased capacity of the main. This is the second time it has been found necessary to clean this main; the first cleaning having been done four years before. The main has now (1914) been in service 14 yrs. and it is evident that the tuberculation forms more rapidly after cleaning than before, since the main was in service 9 yrs. before the first cleaning was required, while only 4 yrs. elapsed after the first cleaning until it was necessary to clean it again. This is evidently due to the scrapers removing a part of the coating of the pipe.

A brief description of the method of cleaning water mains may prove of interest. The main is first opened at two places, the distance between the two openings varying according to the size of the main, and the location of elbows. The cleaning machine is placed in the opening nearest the pumps and the main closed; the pumps are then started and the machine forced through to the second opening by the water pressure. When the deposit in the pipe is very hard, or other conditions require it, a cable is first passed through the main by a carrier and the machine is pulled through with a windlass, at the same time washing the main of sediment and cleanings. The above mentioned main was cleaned without the aid of the windlass as the pumps drove the machine at the rate of 40 ft. per min. with 50 lbs. pressure. A section of this pipe a mile long was cleaned with one cut. The action of the machine may be plainly heard by walking along above the pipe while it is in action.

Table showing loss of head in feet for 100 lineal feet of smooth, straight cast iron pipes:—

Gallons Per Min.	1 inch	2 inch	3 inch	4 inch	6 inch	8 inch	10 inch	12 inch
5	2.32	.08						
10	8.40	.36	.05					
15	18.90	.81	.11					
20	30.10	1.29	.18					
25	45.50	1.96	.27					
30	64.00	2.73	.38					
35	85.00	3.66	.51					
40	109.00	4.68	.65	.16				
45		5.80	.80	.20				
50		7.10	.98	.24				
70		13.20	1.83	.45				
100		25.60	3.52	.88	.10			
150		54.00	7.72	1.82	.23			
175			9.75	2.40	.34			
200			12.80	3.12	.44			
250			19.70	4.80	.66	.16		
300			27.10	6.70	.92	.26		
350				8.80	1.21	.29		
400				11.30	1.58	.40		
450				14.10	1.96	.46	.15	
500				17.20	2.33	.58	.19	.08
750					4.87	1.24	.39	.17
1050					10.30	2.51	.83	.34
1250					13.00	3.18	1.03	.43
1500						4.48	1.49	.61
2000						7.65	2.50	1.02
2500							3.81	1.56
3000							5.30	2.42
3500							7.20	2.80
4000								3.80
4500								4.82
5000								5.82

Table showing friction loss of head in feet, for smooth 90 deg. elbows:—

Gallons Per Min.	1 inch	2 inch	3 inch	4 inch	6 inch	8 inch	10 inch	12 inch
5	.06							
10	.22							
15	.49							
20	.87							
25	1.35	.09						
30	1.95	.13						
35	2.65	.18						
40	3.46	.23						
45		.29	.06					
50		.35	.08					
70		.70	.19	.05				
100		1.41	.29	.10				
150		3.20	.66	.22				
175			.90	.30	.06			
200			1.18	.40	.07			
250			1.84	.62	.12	.04		
300			2.63	.89	.18	.06		
350				1.24	.24	.09		
400				1.59	.29	.10		
450				2.01	.39	.13	.05	

Gallons Per Min.	1 inch	2 inch	3 inch	4 inch	6 inch	8 inch	10 inch	12 inch
500				2.47	.48	.16	.06	.04
750					1.09	.36	.15	.07
1050					2.41	.76	.29	.14
1250					3.02	1.00	.40	.20
1500						1.44	.58	.29
2000						2.44	1.01	.47
2500						3.68	1.57	.75
3000							2.25	1.08
3500							3.05	1.47
4000								1.92
4500								2.43
5000								3.01

Doubling the velocity of water through a pipe increases the friction loss four times, while doubling the size of the pipe increases the capacity four times and increases the carrying power in excess of four times. The following table gives the comparative carrying power of pipes from 1 in. to 14 in.:

1 in.,	1.
2 "	5.7
3 "	15.6
4 "	32.
6 "	88.2
8 "	181.
10 "	316.2
12 "	498.8
14 "	733.4

Water Hammer.

Extracts from a paper by O. Simin, read before the Twenty-fourth Annual Convention of the American Water Works Association:

The question of the so-called water hammer, or hydraulic shock, caused by stopping the flow in a water pipe, is of great practical importance, as the shock frequently bursts the pipe.

Geo. N. Peck describes water hammer as follows: "When a liquid is flowing through a pipe there is a certain amount of energy in the liquid, and if we stop the flow this energy must be used up in some way. If the liquid is incompressible, and we stop the flow suddenly, the energy of the liquid is used up in doing work on the pipe by stretching it or increasing its diameter. If the liquid is compressible, the energy of the liquid is used up in compressing the liquid and stretching the pipe. Nearly all bursting of pipes is due to a sudden checking of the velocity or to the freezing of the liquid."

The following summary and conclusions are based on exhaustive experiments conducted by Prof. Joukovsky, of Moscow, Russia, to determine the effects of water hammer in pipes:

1. The shock pressure is transmitted through the pipe with a constant velocity, which seems to be independent of the intensity of the shock. This velocity depends upon the elasticity of the material of the pipes and upon the ratio of the thickness of their walls to their diameter. Ordinarily, in cast iron pipes the ratio of the thickness to the diameter decreases somewhat with the increase of the diameter; hence the velocity of the pressure wave is a little less in pipes of large diameters than in pipes of smaller diameters. For pipes of diameters from 2 to 6 in. this velocity is about 4,200 ft. per second; for 24 in. pipe it is about 3,290 ft. per second. The speed of propagation of the pressure wave remains the same, whether the shock is caused by arresting the flow of a column of water moving in a pipe, or by suddenly changing the

pressure in the column of water (flowing or standing) in any part and by any other means.

2. The shock pressure is transmitted along the pipe with constant intensity; the shock pressure is proportional to the destroyed velocity of flow and to the speed of propagation of the pressure wave. For ordinary cast iron pipes, of diameters from 2 to 6 in., the increase of pressure, for every foot per second of extinguished velocity of flow, is about four atmospheres (58.8 lbs.) and for a 24 in. pipe, about three atmospheres (44.1 lbs.). For example: Suddenly closing a valve on a line from 2 to 6 in. in diameter, in which the water is flowing at a velocity of five lineal feet per second, would cause an increase of pressure or "water hammer" of approximately 294 lbs., and this shock pressure would be transmitted along the entire length of the pipe with constant intensity.

3. The phenomenon of periodical vibration of the shock pressure is completely explained by the reflection of the pressure wave from the ends of the pipe, i. e., from the gate and from the origin.

4. If the water column continues flowing such flow exerts no noticeable influence upon the shock pressure. In a pipe from which water is flowing, the pressure wave is reflected from the open end of the pipe in the same way as from a reservoir with constant pressure.

5. A dangerous increase of shock pressure occurs when the pressure wave passes from a pipe into another of smaller diameter with a dead end. In this case the shock pressure is doubled when the wave reaches the dead end. Where there are several branches, one from another, this doubling may take place several times and these double pressures accumulate, so that, under unfavorable conditions, the pressure may become very great.

6. The simplest method of protecting pipes from water hammer is found in the use of slow closing gates. The duration of closure should be proportional to the length of the pipe line. Air chambers of adequate size, placed near the valves and gates, eliminate almost entirely the hydraulic shock and do not allow the pressure wave to pass through them; but they must be very large and it is difficult to keep them supplied with air. Safety valves allow pressure waves of only such intensity as correspond to the elasticity of the springs of the safety valves to pass through them.

Electrolysis.

Extracts from paper by Albert F. Ganz, M. E., read before the thirty-second annual convention of the American Water Works Association:

Electric currents may be conducted in two ways, first, by metallic conduction, and second, by electrolytic conduction. Metallic conduction occurs when an electric current passes through a metal, and is characterized by the fact that no chemical change is produced in the conductor, the only effect being the production of heat. Where electric currents, therefore, pass through metallic conductors, such as copper wires, rails, or pipes, they produce no change in these conductors except to raise their temperature. Under all ordinary conditions stray electric currents found on underground pipes are not sufficiently large to heat these pipes appreciably. Under abnormal conditions pipes may, however, carry stray currents of sufficient magnitude to produce heating at moderately high resistance joints.

Electrolytic conduction occurs when an electric current passes through an electrolyte, and is characterized by the fact that the electric current is transmitted by a corresponding transfer of ions in solution, with the production of chemical decomposition at the electrodes where the current enters and leaves the electrolyte. Electrolysis may therefore

be defined as chemical decomposition produced by an electric current. Electrolysis is usefully applied in the arts for the refining of metals and for producing chemical compounds. The writer wants to discuss here the destruction of underground structures caused by electrolysis from stray electric currents which reach these structures.

Chemical compounds in solutions of water constitute the ordinary electrolytic conductors. Pure water itself has such a high resistance that it may practically be considered a non-conductor. It is for this reason that an iron pipe full of ordinary city supply water does not have a lower resistance than the same pipe without water. Water is, however, readily made conducting by the additions of small amounts of salts, and conduction through water is therefore always electrolytic.

Street soils when entirely dry do not conduct electric currents. Under ordinary conditions, however, street soils contain considerable water with salts in solution, generally chlorides, and this makes them electrolytic conductors. When an electric current passes through soil it therefore does so by electrolytic conduction and by corresponding chemical decomposition at the electrodes. Where an electric current leaves an iron pipe for soil it corrodes the iron by this action of electrolysis. It has been claimed in the past that soils may be conducted metallically, but this has been disproved and it is now recognized that the conduction of electric currents through soil is always electrolytic.

Stray currents are electric currents which have leaked from grounded electrical distribution systems and flow through ground and through underground structures. Grounded telephone and telegraph lines produce electric currents through ground of such very small magnitudes that their effects upon underground piping systems can be neglected. Direct-current electric lighting systems in which the distribution is on the Edison 3-wire plan with the neutral conductor grounded, are in American practice provided with such large neutral conductors of copper that practically no stray currents are produced from such systems. This grounding of the neutral in Edison 3-wire systems is to serve as a safeguard and is not for the purpose of using the ground to carry current. Alternating-current lighting systems where grounded generally also produce only small stray currents, and the electrolytic effects from these small stray alternating currents are always negligible.

Electric railways using the running tracks for return conductors often produce comparatively large stray electric currents through ground, and these are the only sources of stray currents which need be considered in practice. Direct current is almost exclusively used from such electric railways and it is the common practice to supply current to the cars from an overhead trolley wire or from a third rail, and to return this current to the power station through the running tracks, supplemented where necessary by return feeders.

In the simplest form of single-trolley railway, the rails are connected to the negative terminal of the generator at the power station, and the only path for current to return to the power station is by way of the running tracks. If the running tracks are laid upon wooden ties above ground with broken stone for road ballast, as is common on steam railroads which run on their own right-of-way, the rails do not come in direct contact with ground, and the return current will be practically confined to the running tracks. If, however, the running tracks are laid below ground so that the top of the rails is on the level of the surface of the street, as is common in cities, then the rails will be exposed for a considerable area to contact with soil. If the tracks are laid on a concrete base a considerable area of the rails will similarly be in contact with the concrete. Since both damp soil and damp concrete are under ordinary conditions conductors of electricity, part of the current returning through the rails will shunt from the rails through the surrounding soil. It will be seen that with the usual connection of positive terminal of the generator to the trolley wire, and the negative terminal to the rails at the power station, the current will leave the

rails for ground at points distant from the power station, and return to the rails in the neighborhood of the power station, in its path back to the negative terminal of the generator. Since every electric circuit must be completely closed, all current escaping through ground must again leave ground to return to the dynamo so as to complete the electric circuit. Where underground metallic structures, such as gas or water pipes, lie in ground in the path of these stray currents, and where these pipes have electrically conducting joints, such as lead-calked joints or screw-coupling joints, current will flow from ground to such pipes and flow largely on such pipes in a direction towards the power station. In the neighborhood of the power station this current will leave the pipes to return to the negative terminal of the generator.

It must be noted that while ordinary soil is a conductor of electricity, compared with metals its electrical resistance is enormously high; for instance, the resistance between the opposite faces of a foot cube of ordinary soil may measure anywhere from 10 to 1000 ohms, depending upon the amount of moisture and the amount of salts in the soil, while the resistance of a foot cube of iron is equal to about 0.0000004 ohm; if, therefore, we take an average value of 100 ohms for the resistance of a foot cube of soil, it is seen that soil has a resistance which is of the order of 250,000,000 times as great as a body of iron on the same dimensions; that is to say, the conductivity of iron is 250,000,000 times as good as ordinary soil. It would seem from this that current would flow almost entirely on the good conducting rails and none through the high resistance ground. Resistance, however, varies directly as the length and inversely as the cross-section of a conductor, and with the large surface of rails exposed to the ground, the cross-section of the path of the current through ground is enormously great compared with the cross-section of the path of the current through the rails. As a matter of practice it is found that where the rails alone are used for the return of current, frequently a considerable portion of the total current actually leaks from the rails through the ground.

From the above considerations it will be seen that the leaking of current from the rails of electric railways, producing stray currents through the ground and on underground piping, does not constitute a source of loss to the railway company, as for instance would be the case with leakage of gas or water. On the contrary, by allowing the current to return by the ground and underground pipes as well as by way of the rails, the total conductivity of the return circuit is increased, and the voltage loss in the return of this current is decreased, so that there is an actual saving of power for the railway company.

From the explanation of metallic and electrolytic conduction given in the first part of the paper, it will be understood that where stray currents flow on underground pipes they do no harm except where they leave the pipes to flow to the surrounding soil. At such points corrosion of the iron from electrolysis will take place, and theoretically there will be a loss of 20 lbs. of iron per year for every ampere of electric current leaving the iron. Some have assumed that with the low densities at which current generally leaves underground pipes, little or no corrosion is produced. A number of experiments made by the writer have clearly shown, however, that even when current leaves iron for street soil at an extremely low density, corrosion is produced which is at least equal to, and frequently greater than, the theoretical amount. This increase of the actual over the theoretical amount is undoubtedly due to secondary chemical reactions set up by the action of electrolysis.

The underground structures which are most likely to be subjected to destruction from electrolysis caused by stray electric currents, are piping systems and lead cable systems. From what has been said above it will be seen that oxidation or corrosion of such pipes or cable sheaths will occur wherever the current leaves the pipe or cable sheath for the ground. In the simplest case, current flows from rails through the ground to the pipes at points distant from the power station, flows along the

pipes, and leaves the pipes to return through the ground to the rails in the neighborhood of the power station. Where the current flows from the rails to the ground, the rails will be corroded, and where the current flows from the pipes to the ground, the pipes will be corroded. If the pipe line is a uniform electrical conductor, then the pipes will be corroded only in the neighborhood of the power station. If, however, the pipe line is not a uniform conductor, as for instance, if there are one or more high resistance joints in this pipe line, then the current on the pipe will shunt around such high resistance joints and produce oxidation or corrosion on one side of the joint. This action gives rise to joint corrosion which is frequently found. Where there are two or more underground piping systems it also frequently happens that current shunts from one piping system to another through the intervening soil, producing electrolytic corrosion where the current leaves the pipe. Such shunt currents are often caused by accidental high resistance joints in one of the pipe lines, and such shunting may occur anywhere and without reference to the location of the railway power station. Where a direct-current trolley railway system passes through a town which has an independent piping net-work, and where the power station supplying the trolley line is in some other locality, then if stray electric currents are produced from the trolley line where it passes through the town, they will flow on to the piping system making this piping system positive to ground and to rails in the direction towards the railway power station, and negative in the direction away from the railway power station. In this case electrolysis of the piping will be produced at the ends of the piping system towards the railway power stations.

Where current leaves a wrought-iron or steel pipe for the ground, the oxide of iron resulting from electrolysis is diffused through the soil and streaks of iron oxide can generally be found in the surrounding soil. Electrolysis of wrought-iron or steel pipes usually results in pits which eventually go entirely through the wall of the pipe. It has frequently been found in practice in the case of gas pipes that where a service pipe lies in clay or other tightly packed soil, it may be pitted through in many places without giving any external sign of leakage because the soil surrounding the pipe maintains it gas tight. When cast iron is corroded by electrolysis, the oxides of iron mixed with graphite usually remain in place leaving the outside appearance of the pipe unchanged. This material resulting from electrolysis of cast iron usually has the consistency of hard graphite, and can be cut with an ordinary knife. There have been many cases in which a cast-iron main was carrying gas or water without any apparent leak, where a single blow with a hammer drove a hole through the pipe. Here the electrolytic action had corroded the iron entirely through the pipe, and the oxide of iron had remained in place, and, together with the surrounding soil, had prevented the pipe from leaking. Whether or not the mixture of iron oxide and graphite resulting from electrolysis remains in place so as to maintain a pipe gas or water tight, depends upon the surrounding soil conditions. It is therefore seen that an underground piping system may be suffering severely from electrolysis without having given any outward sign of the damage. A physical examination with a test hammer is required in the case of cast iron piping to establish definitely whether or not it has been damaged by electrolysis.

For a given current leaving an iron pipe, there is practically no difference in the amount of iron destroyed between cast iron, wrought iron and steel. The electrical resistivity of cast iron is, however, about ten times as great as that of wrought iron or steel, and the usual lead joints in cast iron pipes also have a resistance which is many times greater than the screw-coupling joints usual with wrought iron and steel pipes. For these reasons a given voltage drop through the ground will cause a much smaller current to flow on a cast iron pipe than on a wrought iron or steel pipe, thus practically making cast iron pipes much less subject to electrolysis than wrought iron or steel pipes. The most frequent

damage from electrolysis is found in the case of service pipes where these cross under trolley rails or other underground conductors to which they are positive.

Besides danger from electrolytic destruction of the pipes, stray currents where they flow on underground piping systems frequently enter buildings through service connections and produce a serious fire hazard. For example, current may flow into a building through a water service pipe, then flow from the house water piping to the house gas piping, and then out from the building through the gas service pipe. Such contacts between service pipes or between a service pipe and the lead sheathing of a telephone or a power cable frequently occur through metal ceilings, or where the pipes rest against each other. Such dangerous heating may be produced where the current flows through such contacts or where vibration may momentarily separate the contacts and produce an arc that nearby inflammable material is in danger of being set on fire. The author has in fact found many cases where currents up to 30 amperes were flowing into and out of buildings through service pipes or lead cable sheaths. Evidence of arcing having occurred between such contacts in buildings have also been found. There is no doubt that many fires have started in this way, but it is always difficult to prove the cause of a fire because of the destruction resulting from the fire.

General.

An attempt to lay down any set rules governing the construction and maintenance of water pipes could but meet with failure. The conditions covering the carrying of water for the many uses it is put to in connection with the operation of a railroad, means a problem for each particular system of water pipes. The object of this paper is merely to call attention to some well known facts concerning pipes and the piping of water and to mention other points that have been brought out in railway water supply practice that are perhaps not so well known.

There is an enormous waste of water, not only on railroads but in public water supplies as well. A greater part of this waste may be prevented if the proper steps are taken. A great deal of this waste is beyond our immediate control and it is necessary that we have the cooperation of others to accomplish results. But we are responsible for the condition of the water mains and the waste through these distribution systems is strictly up to us, and the greatest care should be taken as to material and workmanship of these lines.

Water pipes are often laid without proper authority, or without the knowledge of the waterworks department. Almost invariably these lines are improperly laid and the result is leaks and a constant and heavy expense. No water mains should be laid without the proper authority and knowledge of the waterworks department and a careful record should be kept of all underground pipe for it is too often the case that the location of such pipe is left to the memory of some employé who may forget, or leave the service, and the result is that the location of the pipe for the purpose of making a connection or repairs is a tedious and expensive job.

We are inclined to overlook the importance of our water mains for the reason that they are for the most part underground, but if they were brought to the surface the realization of their true condition would doubtless prove an instructive but very unpleasant surprise.

C. R. Knowles, Chairman.
J. B. White,
Jas. Dupree,
John Ewart,
C. F. Warcup,
M. G. Manning,

Committee.

DISCUSSION.

(Subject No. 8, Water Supply.)

[Note: The chairman of the committee on water supply not being present at the convention was later given opportunity to answer some of the questions and otherwise take part in the discussion. Hence wherever Mr. Knowles' name appears in the discussion the replies were furnished by letter.]

Mr. Dupree:—I would like to make a few remarks on the paper. Table 1, showing approximate costs, gives a price of 16 cts. for trenching and refilling for 8-in. pipe with a 4-ft. cover. I believe that the work can not be done for that price in the country where I am from. In the vicinity of Chicago we encounter clay or sand which has to be curbed. We also have trouble with water.

Table 2 gives the approximate cost of laying cast iron pipe on the Iowa division of the Chicago & Northwestern Ry. I am somewhat acquainted with that country. In the case of the 4-in. pipe I think that one pound too much lead is given. In the case of the 6-in. pipe 10 lbs. is allowed, which is 2 lbs. too light. It has always been my practice to order lead at the rate of 2 lbs. per inch of pipe diameter, and I think you will find that this allowance will work out about right. I also make it a practice in laying cast iron pipe to secure a man who is conscientious enough to put in the yarn as it should be put in. To properly place yarn in the bells it is necessary to have it well caulked. I would rather pay the man doing the yarning 50 cts. a day more than the caulker, because anyone can do caulking,—the only requirements being a strong arm and a strong back,—while it takes a mechanic to put in the yarn properly.

Mr. Knowles (by letter): Even though a paper may not possess special merit, if it stimulates discussion and presents a fresh point of view, it will perhaps have fulfilled its purpose quite as well. In glancing over the discussions we can but feel that the effort spent in preparation of the paper has not been in vain.

When the table of costs of pipe laying was prepared, it was realized that it would come in for considerable criticism, for the reason that costs and methods of doing work vary widely in different sections of the country. While it is very hard to secure

an expression as to the costs and methods of others, it is not difficult to secure comments and criticisms on a table when presented in a paper of this kind, and honest criticism is always welcome, whether we agree with the critic or not.

While the practice of allowing 2 lbs. of lead for each inch in diameter of pipe is quite common, it is a "rule of thumb" method at best and does not make for accuracy. As stated by Mr. Dupree, the skill of the yarner has a great deal to do with the proper laying of cast iron pipe, and a properly yarned joint will require less lead than one poorly yarned. We fail to see where we should employ skill in yarning if we are going to fill the joint with lead. The table of lead used may be verified by the lead tables of Clow and the U. S. Cast Iron Pipe & Foundry Co. Therefore we are compelled to stand by the table of lead as submitted.

Mr. Warcup:—Pipes of different manufacture have varied sizes of bells requiring different quantities of lead.

Mr. Knowles:—There is a difference where some standard is not used. The use of American Water Works standards will insure uniformity in pipe and fittings.

The President:—We have men in the audience who have laid extensive pipe lines, especially in the hills and in the mountains, and they can no doubt give us a lot of information in addition to that contained in the report. We would be glad to hear from men of actual experience in the laying of pipe in the hills and mountains, and to get some information to add to our proceedings.

Mr. A. H. King:—The report mentions cement joints. I would like to know whether it is the finding of the committee that a cement joint is practical for water pipes, especially under tracks where vibration occurs.

Mr. Knowles:—The cement joint is given as one among the many methods of making joints but it is not recommended for general use in laying cast iron pipe. It would not be at all suited for pipe laid under tracks.

Mr. Dupree:—I have tried cement joints in every form and under various conditions but have always found them to be a failure for water pipe lines under a pressure of 20 to 25 lbs. or more per sq. in.

Mr. Knowles:—When properly made, a cement joint should withstand an even greater pressure than lead. The greatest

objection to the cement joint is that it is not mobile enough to withstand the unusual strains to which water pipe is subjected.

Mr. A. H. King:—It is our practice to lay siphons with cast iron pipe. These siphons are under pressure and it is necessary to cross under the tracks. The conditions are very similar to what they would be for ordinary water pipe. I have never tried a cement joint, but I do not believe it is possible for it to withstand the vibration under a track. You will readily see that the siphon and ordinary water pipes are similar, in that both must be joined under the same conditions.

Mr. Weise:—The siphon pipe probably comes under this head, because it is a pipe carrying water.

Mr. Rear:—I might explain that we have a very large number of these siphon pipes. In irrigated districts the water is carried in ditches graded up above the general elevation of the ground. When we come to a railroad track we siphon underneath. The water is under as much as 14 to 16-ft. head. In the past, we have had some very bad experiences through allowing irrigation companies to put in poor pipe, leaking at the joints, causing water to come up through the tracks and creating soft places on high speed track. In recent years we have made a very rigid specification of siphon pipes, making it not only necessary to install the best kind of pipe, but also the best joints.

I believe with Mr. King, that a cement joint in a pipe under tracks carrying water under high pressure is not suitable. It should be either a continuous riveted pipe, or cast iron caulked with lead. This is covered very clearly in the second paragraph under the heading of pipe joints. I think the committee had in mind just such connections as would be required in pipe laid under tracks.

Mr. Wolf:—I would like to inquire whether it is the intention to enter into the discussion of pipe for all purposes, or whether the discussion is to be limited to pipe usually found around plants, such as suction and discharge pipes, in which virtually 90 per cent of the trouble occurs. If we go into siphons why not take in soil pipes?

The President:—As I understand the subject, we take in all water conveying pipes. Soil pipes would not come under that head nor open pipe culverts. Suction and ordinary water pressure pipes may be discussed.

Mr. Weise:—Under such conditions siphon pipes carrying

water under pressure and not openings under track for surface drainage may be discussed. Surface drainage does not come under this head, but siphon pipes do, and it is perfectly proper to discuss them. I think some very interesting discussion will be brought out by western men on the subject of water carrying pipes.

Mr. Wolf:—These so-called siphons do not cover the subject we are especially interested in. They are more or less localized and affect the railways only in so far as there might be a leak in a pipe belonging to some one else. It seems to me that we are more interested in maintaining water service for our own purposes.

The President:—I have no doubt it was the intention to cover the water carrying pipes in general use by railway companies. We are not interested in these outside pipes so much, and our discussion will naturally follow along the methods used by our own companies. Any water conveying pipe under pressure would be admissible in this discussion and of still more importance is the various kinds of pipe used. I hope that those having had experience with wooden pipe, especially in the west and northwestern States will give us some good information on wood pipe, because we are interested to know whether or not it is advisable to substitute wood for cast iron.

Mr. A. S. Markley:—It looks to me as though the siphon should be taken into consideration.

The President:—That was the ruling.

Mr. Given:—I recall one case where we laid a mile of 6-in. wrought iron pipe on the side of a mountain two years ago. We had about 500-ft. head and it was necessary to put a pressure break on the line. The cost of laying the pipe in this mountainous country was about $1 per ft.

Mr. J. S. Robinson:—In 1900 we laid about 5 miles of 10-in. and 12-in. cast iron pipe at our Chicago shops. It was laid at a depth of 7 ft. in clay after an experience on another line where we found that pipe laid 5 ft. deep in sand in 1885 was badly pitted. The cost was 70 cts. per lin. ft. for excavation and backfilling, and 25 cts. for jointing. This pipe is in good condition today. We were very careful to see that clay surrounded the pipe completely. Sand and cinders (especially the latter) have a bad effect on iron pipe. The pipe which was removed weighed 120 lbs. and was replaced with 160-lb. pipe on account of making

of it a high pressure line for fire protection. This probably accounts for the cost of the jointing being somewhat in excess of the figures given in the table.

This season we took up some pipe at West Chicago laid in 1880. Where it was laid in sand we found it to be badly pitted, but that which was laid in clay was in perfect condition.

Mr. Sheldon:—The discussion seems to be largely in connection with the lead joint. Has anyone had experience with flanged pipe for high pressure lines and with the elimination of water hammer? In many places with us it is difficult to get a tight joint and maintain it on account of water hammer. We have had to substitute the Universal joint.

Mr. Knowles:—A flanged joint would have no effect in eliminating water hammer. Increasing the strength of the joints only tends to offer greater resistance to the hydraulic shock. A blown-out joint caused by water hammer acts as a relief valve and the chances are that if the joint did not give way the pipe would. There are only three effective methods of eliminating water hammer: first, slow closing gates; second, air chambers of liberal size; third, relief valves. The first method is by far the simplest and it is a preventative rather than a cure, for the reason when the valve closure is proportional to the length of the pipe line water hammer cannot occur. Air chambers of adequate size absorb the hydraulic shock and do not allow the pressure wave to pass through them, but as stated in the report it is difficult to keep the air chambers supplied with air. Relief valves merely allow the pressure waves to pass through them and escape.

Mr. Dupree:—For Mr. Sheldon's information there is manufactured a joint called the Universal. I have never used it myself, but have examined it and think it a very good one.

Mr. Knowles:—The term "Universal" is used to describe a certain type of pipe rather than a joint, although the principal claim to superiority lies in the joint itself. Universal pipe is a cast iron pipe having male and female openings. The outside surface of the male openings and the inside of the female openings are machined on a taper claimed to give the equal of a ground joint. The sections of pipe are put together by means of bolts which pass through lugs. The pipe is furnished in 6-ft. lengths and there are double the number of joints as with hub and spigot pipe. At the same time there is no question but that Universal

pipe has its uses and could no doubt be used to greater advantage than hub and spigot pipe under certain conditions.

Mr. J. S. Robinson:—Our experience with flanged pipe has not been satisfactory on account of the gaskets blowing out and causing leaks. I have heard of the joints mentioned by Mr. Dupree (the Universal) and have examined them, but I am skeptical on the subject of leaks. Where we use 2,500,000 gals. daily, under high pressure and paying at the rate of 7 cts. per 1,000 gals. leaks prove to be quite serious.

Mr. Wolf:—With reference to the flange joints; our experience has been bitter. Where we lay pipe, knowing that it is to carry considerable pressure, such as the boiler or fire lines, we use a metal, and never a rubber gasket. Consequently, the liability to blow out is very remote.

Mr. Spencer:—We have 400 ft. of 6-in. flange joint water pipe which has been in use 5 yrs. On this line the city pressure is 95 lbs. and under this pressure this pipe works all right, but in case of fire we turn on the fire pump when the pressure runs up to 130 lbs. Any pressure above 95 lbs. on this pipe line weakens the joints causing them to leak. We have 5,000 ft. of 8-in. cast iron pipe with bell and spigot ends laid at the same time as that which I have just mentioned. Both lines are under the same pressure, and as this 8-in. pipe line has never given any trouble I prefer it to the other.

Mr. R. C. Henderson:—I have laid about a mile of 12-in. flanged joint pipe on the B. & O., and think it best for both suction and discharge if properly laid. I would block up each length of pipe about 18 in. from the flange. This will give room to do the work on the joints. I find the weakest point in a pipe line laid with this kind of joints to be where the flange joins the pipe and if the pipe is not properly blocked the line is liable to break at the points mentioned. I call to mind several hundred feet of 12-in. flanged pipe that was laid for the B. & O. by a contractor, that gave us trouble nearly every day on account of breaking next to the flanges or the joints leaking through the gaskets. After we dug down and blocked up beneath the pipe as I have mentioned we experienced no further trouble. We had a new suction line laid with 12-in. bell and spigot cast iron pipe beneath the tracks at a depth of from 4 to 5 ft., but the lead joints would become loose from vibration, causing leaks. This was replaced with flanged pipe and we have had no further trou-

ble. It is also necessary in laying flanged pipe to keep it as straight as possible for even a slight bend is liable to cause a break near the joints. Where a bend is to be made, even if very small, it is best to use a special fitting. Nearly any degree of bend may be secured for flanged pipe.

I would like to hear from someone on the subject of water hammer. On the B. & O. we have considerable trouble resulting from it. How do elbows affect the line as regards water hammer?

Mr. Knowles:—Elbows do not contribute directly to cause water hammer, but where water hammer occurs elbows have a tendency to retard and increase the shock when the direction of the pressure wave is changed by passing through the elbow. The greatest trouble from elbows in lines affected by water hammer is in their blowing off the pipe unless properly braced. The same thing occurs with a penstock or a fire hydrant. It is generally necessary to cut a piece of pipe to place a penstock or hydrant. The result is that there is no head on the pipe and unless the hydrant is properly braced a comparatively slight water hammer will blow the hydrant off. I have known this to happen a number of times.

The President:—The question that Mr. Henderson brought up is an important one, and there is a short paragraph in the report on water hammer which I will ask the assistant secretary to read.

(Mr. Weise read the first two paragraphs under the heading of water hammer.)

Mr. A. S. Markley:—I would like to know how to relieve water hammer.

The Secretary:—That is pretty well described in the report. The last paragraph under the heading of water hammer gives about the only solution of the problem. Where cast iron pipes are well embedded in clay or other hard material they may withstand ordinary shocks of water hammer for a long time without doing damage to the pipe line. Elbows and dead ends get the greatest force from the shock, but in loose materials it may affect other portions of the line. We had a case on the Northwestern where we had a 14-in. main, leading from a tank to a water column, which was laid through a bed of sawdust filling for a considerable distance. At first the water hammer caused the joints to pull apart near the elbow nearest the water column.

After some of these joints had been secured with collars and rods others pulled apart farther back in the line, for the sawdust filling around the pipe offered very little resistance, and we had trouble constantly in keeping the pipe line intact. For a long time the expense connected with repairs to the joints averaged more than $20 per week, until we placed a slow-closing device on the water column. This consists of a simple attachment made by the manufacturers of the water crane, which, by turning a wheel, opens and closes the valve slowly, consuming probably 5 to 10 seconds for one operation. The time required for the opening and closing of the valve vexed the firemen for a time, until they understood the importance of the scheme and got used to it, but this arrangement has eliminated the trouble entirely.

Mr. Holcomb:—I have had quite a little experience with a 12-in. pipe line. We recaulked some of the joints for the third time when I told the repairmen to put a relief or pop valve next to the main that was causing the trouble. We put on a 1¼-in. pop valve 5 yrs. ago and have had no trouble, nor spent a cent for repairs since.

Mr. A. S. Markley:—The extent of the damage depends on the direction of the pipe. If laid straight from both terminals there is not much chance for a broken joint. We anchor our pipe in the water crane pit. We experience very little trouble with this method, and one tank is 20 or 25 ft. above the ground.

Mr. Wolf:—I have had but one serious case of water hammer, and that was in connection with a water column from a standpipe. We investigated as to the pressure developed and found as much as 580 lbs. on the pipe at times. Not only was it shoving the pipe apart at the elbows, but in two instances it split the 12-in. cast iron main. We finally tried a scheme of applying a water relief valve, similar to a pop valve, which we built ourselves. It was of about 3-in. capacity. We set the spring at about 25 or 30 lbs. greater than the actual standing pressure in the pipe, and from that day to this—about 4 yrs.—we have had no further trouble. This valve was located just outside of the standpipe pit.

Mr. J. S. Robinson:—We had occasion to connect a penstock to one of our high pressure lines at Chicago shops. We placed an air chamber near the penstock. We suspicioned a loss of water soon after placing it in service, so we placed gages on

the different high pressure lines and we found one line 360 ft. long where we were losing water on account of loose joints. In spite of the fact that we were very careful in caulking, every joint back of the " T " where we left the high pressure line was found to be leaking as the result of water hammer.

As for the slow-closing valves;—we tried five on our penstocks at our Chicago shops engine terminal and found them unsatisfactory because the hostlers, in watering 60 to 75 engines per hour, would invariably break them. The men handling the engines wanted valves that they could " slam over " and stop the flow of water quickly which caused water hammer. We had to remove them, substituting the regular quick acting shut-off valves with relief valves which settled the difficulty.

Mr. Grover:—I have had some experience with water hammer and I have generally found that a good sized air chamber located close to the point of discharge is very efficient. It is not always practicable, and cannot always be put at that point, but where possible, I think you will find it very helpful. One can take an 8-in. pipe, or something of that nature (as long as can be used conveniently), cap it, and put it on the discharge line with 2-in. or 3-in. connections, making a sort of bottle-neck affair. I have tried the relief valve, but I got just about as much satisfaction with this device as I did with the relief valve, and perhaps a little more; it is the air cushion that helps to absorb the shock.

Mr. Wolf:—I neglected to say, in connection with the case I mentioned, that I tried various sizes of air chambers but found that while they would relieve the difficulty for a few days the relief would not be permanent. It appears that the evaporation of the water gradually exhausts the air from the chamber until it becomes filled with water and then we have no air chamber. I think that where excessive hammer approaching or exceeding the breaking point of ordinary cast iron pipe, air chambers will be found to act about that way.

Mr. Sampson:—Some years ago I had occasion to place a water crane at the end of a 6-in. main. This was at the end of a branch pipe line about one-half mile long. Not wishing to go to the expense of setting up a water tank to supply the crane, and in deference to the city officials, who did not like to have us draw directly from the city main, I designed an air chamber at the end of the pipe line and placed it about 50 or 100 ft. beyond the

"T" branch supplying the crane. We used a good sized cast iron chamber, such as is in common use on steam pumps, and connected it to the pipe line with flanged joints. The pipe being about 4½ ft. in the ground necessitated that the air chamber be placed in a brick well in the ground protected from frost by a wooden roof cover. We experienced the trouble mentioned by Mr. Wolf. The air either seemed to ooze out through the pores of the casting or else the water absorbed the air.

We located a glass water gage about 2 ft. long on the side of the chamber expecting that we could then see how high the water stood in the chamber. We found that it contained very little air. The glass gage showed the chamber to be full of water most of the time, and the water being clear we could not determine whether the gage showed air or water by ordinary inspection. We had a pipe and valve tapped into the top of the air chamber and coupled an air hose to it, and arranged to have locomotives stop occasionally on the sidetrack nearby, couple this hose to the locomotive air pump and pump air into the chamber until the glass gage showed air for about half its height. Even though the mechanical department did attach and work the locomotive air pump efficiently, the air would not show in the glass gage for any continued length of time, and the air chamber could not be kept serviceable. We gave up the attempt to run it and finally resorted to a slow closing valve in the pit at the crane, which answered very well as only switch engines in the yard took water from this crane. The city pressure was about 50 lbs. per sq. in.

Mr. Knowles:—In the case mentioned by Mr. Sampson, better results would have been obtained had the air chamber been placed closer to the valves, as in this instance the pressure wave had to travel 50 or 100 ft. before it was absorbed by the air chamber.

Mr. Given:—We have many long pipe lines in the mountains. We have one line 2 mi. long supplying Roseville terminals and other lines, each of which is probably a mile long. We do not have any trouble on account of water hammer, the probable reason for this being that we use slow closing gate valves on our tanks and our reservoirs are close to the tracks.

Mr. M. Fisher:—I have not had very much experience with water hammer. While we have a number of pipe lines, we have always been able to overcome water hammer with relief valves.

We have a pipe line 56 mi. long with a number of breaks in it to overcome the pressure, and also to avoid water hammer. We have a stretch of about 16 mi. equipped with relief valves, which take care of the water hammer very successfully. This line was originally laid with wooden pipe, but during the past summer we renewed 14 mi. with cast iron, as the wooden line was getting rotten at the joints, making it hard to maintain. It will probably be only a matter of a year or two before we will have to renew 14 mi. more. This line was laid in 1907, and the thickness of pipe was 1 in. It was laid in very bad ground. Half of the line was laid in the old Salt Lake mud flats. This was wire-wound wood pipe, and the joints caused much trouble. The other half was laid in sand and gravel. I believe if the pipe had been kept full of water in the sand and gravel we would have secured much better service but we did not have sufficient water to fill it.

Mr. Spencer:—Was the pipe laid to a regular grade, or up and down?

Mr. M. Fisher:—Up and down.

Mr. Spencer:—In Wyoming, we contracted a job, laid on a grade up and down, and water hammer was not provided for. In one year after that the city ordered us to lay 2 mi. of cast iron pipe in the same line. I told them that we would take up the old wood pipe and lay it on a grade and that we would put in air chambers to relieve the water hammer. We did so and have had no trouble since, although that was years ago. I think a lot of damage is done to wood pipe by improper laying. I know of one pipe that has been in the hills for 16 yrs. It is a 12-in. line, located in the city of Edgemont, carrying 90 lbs. pressure and is 4 in. thick. It is wrapped with wrought iron bands, was asphalted when laid, and filled around with yellow clay.

Mr. M. Fisher:—The contour of the country often determines whether one can lay to a regular grade or not. We came down out of the mountains and encountered a surface that was nearly level. Here, the pipe was laid to a grade for 14 mi. This made no difference as to the life of the pipe. There is only about 4 ft. of fall in 14 mi. of line. The pipe was 8 in. in diameter.

Mr. T. J. Stuart:—We are confronted with the same conditions on the other side of the mountains, across the flats, in Utah. We have 22 mi. of pipe line of various sizes and under different heads. We come down an 800-ft. mountain slope and go 400 ft. across the flat. Our experience has been that where

the pipe is kept under water and under ground it lasts pretty well. We have just finished laying one-half mile of pipe under 400-ft. head. The chemical action of salts in that country is such that it eats the bands off the pipe, and we have many lines on which the winding determines the strength of the pipe. We have pipes under 400 to 450-ft. head. In 1907 we built a reservoir of 200,000-gal. capacity with a 50-ft. head from which we laid a direct line wound for a 250-ft. head to a 12-in. standpipe. We had much trouble on account of water hammer. To overcome the trouble we went to the standpipe and tried various mechanical devices without success. Instead of connecting to the main track standpipe we laid the line into a water tank and took an independent line from the water tank to the standpipe since which we have had no trouble. I am not in favor of long wood pipe lines under high pressures. Gravity lines are all right, but wood pipe under pressure will not stand up.

Mr. Rear:—The pipe we are most interested in, in this part of the country, is the wood stave. Some tell us that it will last forever, and others say that it will not last more than three or four years. We have had some experience with it ourselves which was not favorable. I would like to have someone tell us how long this wood pipe will last, and the reason that it will not last in some locations; whether soil conditions affect the pipe; whether its short life is due to the fact that it is not always full of water, or whether it is on account of the pipe being too thick. I understand that the pipe can be made too thick; that the thickness of staves has a great deal to do with the life of the pipe and that under certain conditions the thinner staves will last longer than the thicker. Of course some soil conditions will probably eat the pipe away very fast. This is the kind of information I would like to get.

Mr. Knowles:—Mr. Rear's question as to the required thickness of wood stave pipe may be answered best by quoting from Andrew Swichard, hydraulic engineer in *Engineering and Contracting* for Nov. 4, 1914, as follows:

" The thickness of staves must be such that when the bands are properly tightened the result will be a tube of sufficient rigidity to withstand any outside pressure that will come upon it, such as the weight of the back filling when the pipe is laid in a trench, pressure due to a partial vacuum and the reaction of the supporting bed due to the weight of the pipe and the weight of

the water within the pipe. Hence, staves too thin may result in a collapsed pipe, while on the other hand, if they are thicker than necessary, the degree of saturation of the outer surface is less than with thinner staves, and the resulting conditions are better for the starting and growth of decay. The saturation of the staves with water is the only effective preservative. Its effectiveness as a preservative depends on the approach of the degree of saturation to that resulting from complete immersion in water. Any feature of design or location that interferes unnecessarily with the saturation of the staves should be avoided. Decay once started makes rapid inroads; prevention of the beginning should have every attention, because, at the best, decay will make some progress."

Mr. W. C. Frazier:—About 1890, I laid about 3 mi. of 24-in. wood stave pipe for the city of Long Beach. It was a continuous pipe of redwood staves, 1¼ in. thick, and was supposed to have been built for a 75-ft. head. That pipe is still in service as a flow line. It has been taken up and relaid twice since originally placed. It never was really satisfactory on account of leaks. It seemed to be impossible to keep the line entirely tight, but I have always maintained that this was due to the fact that the pipe was used part of the time as a suction line. I have had other experiences with wood pipe as a suction line leading to a pump, and it always has been very unsatisfactory.

In Las Vegas, Nev., considerable wood pipe is used, comprising the greater part of the water system. This pipe is wound for 75 to 150-ft. head, and ranges in diameter from 18 in. down to 4 in. It has redwood staves, ranging in thickness from 1 in. to 1¼ in. In that particular location this pipe has proven extremely unsatisfactory due to unfavorable soil conditions more than anything else, as we have been unable to hold the bands. The soil is a gypsum formation and it cuts the bands in two. We are continually working on these pipes and it is often necessary to put on individual bands. For the last two or three years we have had a gang of three or four men working continually on these pipes. I am not in favor of wood pipe, except for flow lines. I believe that with a very light head on flow lines the pipe can be kept fairly full and will give satisfaction. I have had no experience with other than redwood pipe, which is supposed to last as well in the ground as any.

Mr. Knowles:—Wood stave pipe is not satisfactory for a

suction line, or in fact for any service where the flow of water is intermittent. To avoid decay of the pipe it is necessary that the wood be saturated and this can only be accomplished by keeping the pipe full of water.

Mr. J. P. Wood:—I would like to ask Mr. Frazier what kind of soil the pipe line is laid in that he mentioned.

Mr. W. C. Frazier:—In very heavy clay, impregnated with gypsum at depths varying from 18 in. to 4 ft. This gypsum is always full of water. Trenches were dug and the pipe laid in the ditch and banded with individual bands. So far as the wood itself is concerned, I think the pipe would last indefinitely in our soil. These bands were asphalted in all cases before being put on. A great deal of the pipe was not coated inside with asphaltum before being placed, but the entire line was covered on the outside with a heavy coating of asphaltum, after being set in place. I think the bands used are the most practical. We have used some galvanized bands with very poor success.

In regard to the formation I spoke of at Las Vegas; we had some trouble on account of encountering gypsum which has a tendency to slack and heave. In some cases the pipe line would heave out of the ground after exposure to atmosphere, and we would find the gyp slacking like lime, leaving the pipe line dried up.

Some of our people bucking the water proposition on the deserts have real water troubles. We have one pipe line 14 mi. long, laid with the contour of the country (and the contour of Nevada is very bad) with which we have had a great deal of trouble. At Saline we have a 3,000-gal. reservoir into which this pipe empties. We have trouble with air pockets for while we have two air valves to the mile they will stick on account of the uneven contour of the country. The air will gradually work in and pocket in these places, and the first thing we know we have no flow into the reservoir. It is then necessary to cut the pipe line to let the air out and the water through.

Mr. Staten:—The city of Lynchburg, Va., sent over to California for 16 mi. of pipe for use in that city. Lynchburg has a large foundry for cast iron pipe and I have seen a carload of cedar pipe and a carload of cast iron pipe for the same place. Cedar pipe did not give satisfaction in Lynchburg and it does not seem to do so out here. Often when they are working on the pipe in Lynchburg we have no water available in the city. I

do not know whether the trouble is caused by the dams, by the pressure, or what, but we are always in trouble. I believe this pipe is 16 in., with about 1½-in. staves. The bands were pretty thick, and I think were made of copper.

Mr. Rettinghouse:—While at Parker, S. Dak., recently, my attention was called to a line of 6-in. wooden stave pipe, which had been taken up and was being replaced with cast iron pipe of a larger diameter. The wooden pipe in question had been in the ground for over 30 yrs. and I satisfied myself from personal inspection that the same was in perfect condition. The pipe was of standard make, manufactured out of pine lumber in about 6-ft. lengths, wound spirally with strong iron hoops and covered outside with pine tar. It is my understanding that the wooden pipe was again to be used for a branch line in an outlying district. It is my further understanding that this pipe was subjected to a pressure of 50 lbs. per sq. in.

Mr. J. F. Parker:—We have not had any experience with wood pipe on this division, but the orange groves adjacent to the city of Corona are irrigated through pipe lines and open ditches from Ferris Valley, a distance of 20 mi. For a part of the distance the water passes through wood pipe of California redwood 30 in. in diameter. It crosses and parallels the Santa Fe track for 6 or 7 mi. The pipe is built of continuous stave, fastened with individual bands set up by lugs. Although I have never had any experience with this pipe I watched its installation and see it every time I go over the road.

Mr. Dupree:—I believe that in cases where there are a number of tracks and the speed is high it would be a good plan to lay the pipe about 6 ft. underground to avoid sudden jars.

Mr. Morrison:—At South San Francisco, a pipe passes under our track in a conduit, and there does not seem to be sufficient vibration to disturb the joints.

Mr. Wolf:—We have considered the question of joints in cast iron pipe under tracks and have tried in some cases to remedy the trouble by placing a concrete collar around the joint. During the past four or five years we have adopted almost entirely a plan of placing our water pipes in conduits. The conduits are very large and sufficiently roomy to allow a man to crawl through, should a joint happen to spring a leak. In all cases where we put the pipe in conduits we have had no trouble.

Mr. J. S. Robinson:—I think the conduit scheme a good one

but it is generally too expensive for locomotive water supply. The cost of installation is more than double that of the pipe line.

In regard to vibration; we had at one time a line of cast iron pipe about 1½ mi. in length laid at a depth of 5 ft. in clay and sand under and between the tracks at DeKalb, Ill. Investigation revealed the fact that the joints were in good condition where the line was laid in clay but many of the joints leaked badly where it was laid in sand. The leaks occurred about 400 ft. apart. To overcome the difficulty we relaid the line in the sand pockets and drove piles to support the joints, whereupon we experienced no further difficulty.

Mr. J. P. Wood: Is it not a fact that many of the members present have secured better results by laying pipe with their own forces than by having the work done by contract?

Mr. A. S. Markley:—That depends upon how closely you watch the contractor.

Mr. Wood:—I have thought a great many times that it is a question of how closely you watch the inspectors. .

Mr. Dupree:—As much does not depend on the contractor as on the man who is doing the work. I believe that 99 per cent of the contractors doing this kind of work are honest and capable but they will hire almost anybody. I worked six years for a contractor who built nothing but pipe lines, water softening plants, etc., for railroads. This contractor always told me to do a good job and I endeavored to follow his instructions.

Mr. Knowles:—It is more satisfactory and you secure better results by laying pipe by your own forces, providing you have an organization for that purpose, but if it is necessary to organize a gang for each job, or to attempt the work with a gang whose duties are along other lines, you had better let a contractor have the work, and trust a little to the contractor and a little to the inspector, but keep an eye on both.

Mr. Hadwen:—Nothing has yet been said in regard to incrustations. We have been told of damage caused by this to the exterior of wooden pipes, due to the action of alkali, etc., in this acid-laden country. There is a section of the paper devoted to incrustation, and I think that in this country where alkali is troublesome we could get some information regarding the damage to iron pipes from that source.

The President:—We are having trouble of that kind with

steel water tanks in the central States; I suppose it is worse in the western country. Have you ever had any trouble with wood pipe due to this cause?

Mr. M. Fisher:—The water we use comes from the mountains and we are not troubled with incrustation.

Mr. T. J. Stuart:—Were you ever troubled with growths inside of water pipe?

Mr. M. Fisher:—Nothing more than roots of willows which grow at the upper end of the line. We have a man whose regular duty it is to examine the intakes and keep them clean. These roots will continue to grow and unless removed will stop up the pipe.

Mr. King:—We have experienced trouble with alfalfa roots getting into the joints of our wood pipe and continuing to run for 75 or 100 ft. They are getting to be of good size and will have to be cleaned out. The intakes are protected by screens.

Mr. Wolf:—Have you ever met with growth throughout wood pipe—a sort of velvety or mossy composition?

Mr. King:—I have never seen anything of that kind.

Mr. Stuart:—We have a 4-in. wood pipe, 3½ mi. long, with a gravity flow. Moss gets into it to such an extent that it is necessary to cut the pipe to remove it. It will not grow in cast iron pipe. The water in this mountainous district comes from springs and running streams, where willows abound. They will start to grow in wood pipe and attain a length of 75 to 100 ft. We had to take up 4-in. and 6-in. wood pipe, as it choked up.

Mr. Wolf:—Up to a few months ago I had a line (about 7,000 ft.) of 2-in. old-fashioned "pump-log," driven together, which became full of something resembling moss, with a soft velvety touch. It would not have paid us to clean the pipe and we had to throw it away. I wonder if that was a condition generally found in gravity-flow wood pipes. This pipe was fed by a small stream. The supply pipe was choked so badly as to permit of the passage of a stream only about ½ in. in diameter.

Mr. Rettinghouse:—In the state of Iowa the Chicago & Northwestern has 17 water treating plants on its main line between Clinton and Council Bluffs. At several of these plants there are pipe lines varying from 2,000 to 6,000 ft. in length conveying the treated water to delivery tanks and standpipes. Although the water is permitted to settle in settling tanks for about 24 hrs. after being treated it still holds in solution (or

suspension) while being transferred from the settling tanks, considerable lime which precipitates on the walls of the pipe lines, forming a hard, stratified scale. This precipitation continues, forming rings similar to the year-rings of trees, so that gradually the pipes become nearly filled.

At three of the treating plants which had been in service about 8 yrs. it became necessary to clean the pipe lines in 1908, and a contract was let to a pipe cleaning firm located at New York City for cleaning the pipe lines at Tama, Belle Plaine, and Missouri Valley. This was done mechanically by breaking into the pipe at intervals of about 200 ft. and pulling a rotary cutting device through. The results were very satisfactory. At Belle Plaine 5,044 ft. of 6-in. cast iron pipe was cleaned. Before cleaning it was necessary to pump with a pressure of 125 lbs., which forced the water through the pipes at the rate of 248 gal. per min. After cleaning we were able to deliver water at the rate of 335 gal. per min. with a pressure of only 60 lbs. At Tama 5,193 ft. of 4-in. cast iron pipe was cleaned with the result that while it required a pressure of 135 lbs. and 48 hrs. to fill a tank before cleaning, the same tank was filled in 10 hrs. with but 35 lbs. afterwards,—the same pump being used in both instances. At Missouri Valley we cleaned 2,075 lin. ft. of 6-in. pipe. We made a careful test at this plant and found that, conditions being alike as to pump and steam pressure, we were able to pump through the cleaned pipes 4.38 times the amount of water that we were able to pump before cleaning.

I left the Iowa division in April, 1912, and have not since that time kept acquainted with the situation personally, but I find on consulting with the men now in charge that the pipes again have become partly filled so that in about a year it will again become necessary to clean them.

The question has been brought up regarding pipes filling with vegetable matter. I recall a case which came to my notice about 15 yrs. ago in Wausau, Wis. The city water supply was obtained indirectly from the Wisconsin river by means of a series of open wells sunk in the gravel bed. The gravel acted as a natural filter and an abundant supply of clear and wholesome water was obtained. It was noticed, however, that the pipe lines, where much water was used and where consequently there was a constant current of water, became partly filled with a fungus growth while dead-end lines were entirely free from such

growth. Unfortunately I am not in a position to say what was finally done to clean the several miles of pipe lines which were affected, but I am inclined to think that mechanical means had to be resorted to. In fact it was strongly advocated at the time I left Wausau. In my opinion mechanical cleaning is about the only remedy in cases of this character.

Subject No. 11.

CONCRETE POSTS, POLES AND SIGNS.

REPORT OF COMMITTEE.

Concrete Posts.

Owing to the rapidity with which the forests are disappearing large users of timber are casting about for materials which will be suitable as substitutes and which will be of a more permanent nature. One of the items in railroad maintenance requiring a large amount of timber is fence posts. As the supply of standing timber has decreased, the quality of the posts secured has, in general, deteriorated quite markedly, while the price has advanced considerably.

At present wooden posts are as low in first cost as any of the substitutes offered and, in many instances lower. But because of their short life, and liability to destruction by fire, it is questionable whether any wooden post (with the exception of one or two kinds) is as economical as a well-designed and well-manufactured concrete post, although the first cost of the concrete post is generally in excess of the wooden one.

Farming communities seem to have been the first to feel the effects of the increased price of posts, and they were the first to search for a suitable substitute for wood. Little or no progress was made in the design of concrete posts until the railroads took the matter up for study and investigation. At that time reinforced concrete was coming into use quite generally as a substitute for timber in building and bridge work, and many persons in all parts of the country took up the study of reinforced concrete as a suitable material for fence posts. Naturally some errors of design occurred; many posts were poorly made; and many failures resulted. Also, as is usually the case in a new field, there were some whose enthusiasm outran their judgment and extravagant claims were made, which could not be substantiated. The posts were found to be difficult to handle because of their weight, and they were easily broken. Difficulty was also experienced in finding a satisfactory method of fastening the fence to the post, particularly to those of the earlier types which were straight or had a very slight taper. Notwithstanding all these drawbacks, concrete posts have established themselves permanently as a fence material, and as the supply of wooden posts continues to diminish, their use will increase rapidly.

Another substitute for the wooden post has been brought out recently. This is the steel post. While it is not the province of this committee to investigate the merits of this type, it may be of some interest to mention it as the only other substitute for the wooden post which has been used to any considerable extent. This type of post was first manufactured about 15 or 20 years ago. Many were put in service at that time, and it is stated that the results obtained were very satisfactory, although their use was quite largely confined to the locality in which they were manufactured. Efforts have been made by the manufacturers to extend their use in the last three or four years. What few have been installed for right of way fences have not been in service a sufficient length of time to justify conclusions as to their merits.

In the vicinity of slate quarries in eastern Pennsylvania a great many posts of slate can be found. It is stated that these are very durable, and fulfill all the requirements of a good post. Their use will naturally be restricted to the localities where slate occurs.

To secure extended use any form of fence post must fulfill the requirements of stability, durability, efficiency and economy. Experience has shown that the concrete post is as stable as the wooden one. The very characteristic weight, which makes it difficult to handle during manufacture and while being distributed, is a marked advantage in securing stability after it has been set. Again, when used in low wet places, and in localities subject to overflow, the advantages of the concrete post are apparent.

Concrete posts have not been in use a sufficient length of time to determine their life, but judging by the service of concrete under other circumstances, we may safely predict a life of 40 years for a properly designed and constructed post. Concrete posts installed some years ago have already outlasted many varieties of wooden posts, and to all appearances are in condition to last many years more.

Experience shows that the concrete post is as efficient as the wooden one. It has the further advantage of not being liable to destruction by fire.

When we come to the question of economy, the weight of evidence is in favor of the concrete post. Wooden posts cost from 10 cents to 30 cents, depending on the kind of wood and the locality. A conservative average for those most commonly used is 16 to 17 cents, and their average life from 12 to 15 years. Concrete posts cost from 16 to 20 cents with the average for the heavier posts about 18 cents. It does not require any complicated calculations to determine from these figures the relative economy of wooden and concrete posts. Concrete posts have the further advantage that they can be made near the point where they are to be used.

When it became apparent that some substitute for the wooden post must be found, many designs were brought out. Shapes varied from square and rectangular to round or triangular. There were also T-shaped posts and semi-elliptical, and rectangular sections with one end semi-circular. In size they varied from 3 in. to 6 in. at the top and from 4 in. to 8 in. at the bottom. In some types the post was spread at the bottom like a footing. Many of the early posts were made straight or with a very slight batter. All of the shapes mentioned are in use and each one has its advocates. As the forms for the manufacture of these posts are nearly all patented the committee does not wish to make definite recommendations as to the shape. It believes, however, that in general those sections having the smaller perimeter for any given area will prove the most satisfactory.

Experience has shown that straight posts, or those with a very slight batter, are likely to heave with the frost. In these forms it is also difficult to prevent the fence from slipping down on the post. For these reasons posts are now generally made with a decided batter. The committee believes the taper should be uniform from top to bottom.

It has been found that the lighter posts are not always able to resist the strain to which they are subjected, especially in those sections of the country where stock is plentiful and the recent tendency seems to be toward the use of a heavier post. The advantages of the lighter posts are the decrease in cost, due to the smaller amount of material used, and the lighter weight of the post which is an advantage in handling and shipping. The latter advantage is offset to some extent by the fact that greater care must be used to prevent breakage. The committee recommends a minimum diameter of 4 in. at the top and 5½ in. at the bottom.

The types of reinforcement are nearly as numerous as the shapes of the sections. They can be divided into two general classes: Core

reinforcing, and reinforcing near the circumference. The reinforcing material consists of plain round or square rods, hoop steel, steel wire, sheet steel cut and pressed into the required shape, twisted or corrugated bars, and in some types a combination of two of the above. In some types the rods are wound with wire, and in others crimped wires are used. The committee believes that reinforcing should be placed near the circumference of the post where the greatest stresses are likely to occur and where the tendency to crack is greatest. The critical section of the post is near the surface of the ground and frequently extra reinforcing is placed at this point. The committee does not believe this is necessary, but it may be found desirable under special conditions where posts are subjected to unusually hard service.

In general, concrete for posts is made of crushed rock or screened gravel, though bank gravel is frequently used. The latter material usually is not as clean as the screened gravel and under these conditions as good results can not be expected. Again, better proportioning of the material can be obtained with the stone or screened gravel and sand. The concrete should be as dense as possible. Increasing the density of the concrete decreases the amount of absorption and the liability to corrosion of the reinforcing. It also prevents disintegration of the post from the action of frost to a considerable extent. For this reason posts should be made of a comparatively rich mixture. The cost of the cement even in a very rich mixture is a small proportion of the total cost of the post, and the cost of the additional cement which makes the difference between a lean and a rich mixture is negligible.

When bank-run gravel is used the proportioning of the sand and coarser aggregate is rarely ever uniform. Theoretically this calls for a variation in the amount of cement used. As it is not practicable to test every batch of gravel received, and as cement is only a small part of the total cost, it is much cheaper in the end to use enough cement to make a dense concrete and a resulting strong post. In making concrete for posts, as for other purposes, it is found that materials from various sources require different amounts of water to make a mixture of the proper consistency. There is also some difference in the amount of water required, depending on whether the concrete is hand or machine mixed. More water is required in hot, dry weather than in cool, moist weather. In hot, or very dry weather, it is good practice to pour water on the stone or gravel before it is used. In view of these varying conditions it is not possible to make any hard-and-fast rule as to the quantity of water to be used. The amount required is almost entirely a matter of experience, but it is a good plan, after sufficient experience with the material being used, to require the man in charge of the mixing to measure the amount of water used in each batch of concrete. Those who have not tried this will be surprised at the difference in the results obtained over the method where the amount of water is "guessed at" for each individual batch. Also by doing this the tendency to make the mixture too wet is largely overcome. It also checks the tendency to make water take the place of thorough mixing.

Because of the comparatively small section of a fence post, and the placing of the reinforcement, it is important that the coarser aggregate should not be of large size. Experience has shown that the gravel or crushed rock should be not more than ½ in. nor less than ¼ in. in size. If bank-run gravel is used and it contains material larger than ½ in. it should be put through a screen and this material removed before using.

The density of the concrete is dependent on several things. First, the quality of the aggregate which should be good. Second, all voids should be completely filled. This requires that the materials shall be properly graded and then thoroughly mixed. Finally, there must be sufficient cement to cover all the particles with a film, and to fill all the interstices. The committee, therefore, recommends a mixture consisting of 1 part of cement to 2 parts of clean, sharp sand and 4 parts of broken

stone or screened gravel, the latter to vary in size from ¼ in. to ½ in. Where bank gravel is used we recommend a mixture consisting of 1 part cement to 4 parts of gravel.

Because concrete posts are more or less proprietary, and because each manufacturer has his own type and manner of reinforcing, the committee refrains from making recommendations on this feature, but there are a few principles relating to this matter which should be mentioned. For the reasons stated above, we believe posts designed with the reinforcing near the outer surface are more likely to give satisfactory results. It should be placed as near the surface as it is possible to get it and still have it protected, but it should not be placed so close to the surface that it will be exposed by slight scaling or chipping while the post is being handled. We therefore recommend that it be placed ½ in. below the surface. We also recommend that the reinforcing material be long enough to permit turning it down at the ends.

Recent experiments have established the fact that slightly rusted reinforcement gives a much stronger bond with the concrete than does the clean, bright metal, or metal with the mill scale on.

Wherever possible, concrete for posts should be mixed in a batch mixer, as machine mixed concrete is conceded to be superior to the hand mixed article because of its greater uniformity. The result is a denser and more uniform concrete. This is a condition that must be obtained if the best results are sought, and a post with a maximum life produced. The materials, including the water, should be measured. The quantity of any of the ingredients entering into concrete should never be guessed at. The water should be sufficient to produce a quaking mixture. A mixture of this consistency will be wet enough to settle around the reinforcing and produce a smooth surface. If made wetter there is danger that part of the cement will be washed off the sand and stone and rise to the top.

Posts should never be made during freezing weather. A reliable product can not be obtained if the concrete is allowed to freeze, or even if the temperature is so near the freezing point as to retard materially the setting of the cement. On account of the small section of a post it is more readily affected by low temperature than is concrete in large mass. For the same reason, concrete posts are likely to dry out rapidly in hot or very dry weather and it is essential that they be kept moist for the first week or ten days, during which time they should not be exposed to the sun.

After the post is cast it should remain in the mold for three days and it will be better to allow it to remain four days. As soon as the concrete is set, water should be put on and the post kept thoroughly wet until removed from the mold. After removal from the mold the post should be stored under cover, in such manner that it can be kept moist for the period specified. If necessary, it can then be removed and stored in the open. Great care must be exercised in handling the posts at this period as they are very easily broken. They should be stored upright with the larger end down. Concrete gains rapidly in strength and the bond between the concrete and reinforcing increases rapidly up to 30 days, and only slightly less rapidly during the next 30. At the end of 90 days the post can safely be used if care is taken in handling. Posts should not be set within 90 days after they are made.

In casting posts, difficulty is frequently experienced with the concrete sticking to the mold. To prevent this it is customary to oil the surface of the mold or to brush it with a solution of soap, but either oil or soap should be used sparingly. The molds should also be scrubbed and cleaned with a stiff broom frequently.

The size of the plant required for the manufacture of concrete posts will depend upon the number of posts required and on local conditions; and the planning of a plant will, in each case, have to be decided after a thorough study of the situation. It can be said that it is generally de-

sirable to have equipment for a daily output of at least 400 posts. This will require molds for 1200 or 1600 posts depending on whether they are left in the molds three or four days.

It is a mistake to think that responsibility for the product ceases when curing is finished. The handling and shipping are fully as important as the actual manufacture. Wooden posts can be thrown about, piled in cars, or on the ground, and handled very roughly without impairing their value in any way. This can not be done with concrete posts. The utmost care must be exercised in handling. This is true of the well manufactured and well cured post; it is more particularly true of the green post, which may be broken by a very slight jar. When shipping, the posts should be carefully packed in straw or sawdust. In unloading they should not be thrown on the ground, particularly if it be hard or uneven.

Concrete posts are set in the same manner as wooden ones, and under normal conditions a man can set as many concrete as wooden posts in a day.

Many methods of fastening the fence to the post have been devised. One device consisted of small holes through the post at stated intervals and nails or wires run through them to be bent around the fence wires. In another type wooden blocks were inserted and anchored in the post during manufacture. In some types staples were placed in the post while the concrete was green. None of these methods proved satisfactory. Holes or staples could not be located where the fence wire would come as it is seldom possible to set the posts at exactly the same depth. Irregularities in the ground also caused difficulties with this type of fastening. Also the staples rust out sooner or later and they can not be replaced. Holes and wooden inserts weaken the post and are unsatisfactory.

The most satisfactory method found up to the present is to use "tie wires" around the post, attaching them to the fence wire by means of the "Western Union twist." Care must be exercised to have the "tie wires" tight and the fence wire drawn up snug to the post, otherwise the fence will slip down on the post while stock running against or trying to get through will raise or force the fence down. This method of fastening the fence to the post will be most satisfactory where the post is made with a taper.

Conclusion.

In conclusion, the committee believes the concrete post to be a suitable substitute for the wooden post, fully as reliable and more economical. It is a mistake to try to reduce the cost of the post by making it of too small section or by cutting down the quantity of cement used. The minimum size should be 4 in. at the top and 5½ in. at the bottom, and the post should taper uniformly throughout its length.

Posts should be properly cured and carefully handled. Otherwise the quality will be poor and the breakage will be large, resulting on the one hand in an unsatisfactory post, and on the other in increased cost due to loss of product.

Care must be used in the manufacture and posts must not be made in freezing weather or allowed to dry out within 10 days after they are cast.

Concrete Poles.

What has been said about the diminishing supply of timber in connection with fence posts applies equally to poles, whether telegraph, telephone, trolly poles, or transmission line poles. In considering concrete as a substitute for wooden poles we find, however, that the situation is quite different. The concrete post is an economical substitute for the wooden post. It is easily manufactured and can be handled with practically the same forces as have been used to handle the wooden

post, while the method of handling, aside of the extra care required is not radically different. On the other hand the cost of the concrete pole is high, the handling of the forms is troublesome, the pole itself is not easily handled and because of its great weight it requires methods radically different from those required by the wooden one. Notwithstanding these and other disadvantages, there are a number of points in its favor. A number of concrete telegraph poles have been put in service in this country, notably on the Pennsylvania, where it is understood they proved very satisfactory during the unprecedented winter of 1913-4. During the most severe storm of the winter practically every telegraph line across the state of New Jersey was down except the line of concrete poles along the Pennsylvania. In some instances the interruption to service lasted several weeks.

In view of this it would seem that we would be justified in undertaking the extra expenditure to safeguard heavy and important lines. We do not believe, however, that we can in any way justify such cost for lighter and less important lines.

Quite a number of lines of concrete trolly poles and concrete pole lines for carrying high tension power lines have been built in foreign countries, but so far as the committee can find, little satisfactory data is available regarding them. There is considerable general information on the subject but it is difficult to get sufficient reliable data on the cost of design, manufacture, etc., to enable one to draw definite conclusions. The committee would, therefore, recommend this as a subject for further study.

G. E. Boyd, Chairman.
A. S. Markley,
C. W. Wright,
F. J. Conn,
W. E. Elder,
Committee.

DISCUSSION.

(Subject No. 11, Concrete Posts, Poles and Signs.)

A S. Markley:—I do not concur with the report in all particulars. I think 30 days long enough, in ordinary weather, to hold posts before shipping. The consistency of concrete must be taken into consideration as well as weather conditions to determine the amount of water necessary. More water is required in extreme hot weather than when cool and damp. For these reasons men in charge of work must be capable of judging the amount of water required to properly temper the concrete.

Even under the most favorable conditions I doubt if concrete posts 4 in. by 5 in. in size and 7 ft. long can be made at the prices named in the report, viz., 14 to 15 cents each. Seasoned concrete weighs 168 lbs. per cu. ft. A post of the size I mentioned weighs 84 lbs. requiring ½ cu. ft. of concrete, or 54 posts per cu. yd. Figuring the posts at 15 cts. ea. would make the concrete amount to $8.10 per cu. yd., which is hardly sufficient.

Local conditions will, however, to a certain extent, govern the cost of production. Under ordinary conditions, in the middle west, using washed gravel and sand, the cost, without overhead charges being taken into consideration, will be about as follows:

1/40 cu. yd. of gravel, @ 75c,	$0.02
1/6 bag cement, @ 35c,	.06
3 reinforcing rods, 1/4-in.,	.07
1 laborer, @ $2 per day,	.04
1 laborer, @ $2.75 per day,	.05
Total cost per post,	$0.24

Fifty-four posts at 24 cts. each would make the concrete cost about $12.96 per yd., which is about as cheap as good concrete can be made in small quantities.

Some manufacturers use a sheet iron separator to maintain proper and uniform spacing of reinforcing rods. Some of these are about half the area of the cross-section of the post and they weaken the post considerably, especially if placed near the ground line. Usually three reinforcing rods about 1/4 in. in diameter are used in each post; one in the center near the bottom of the form on the convex edge, and the other two near the top edge,—all 3/4 in. from the surface. If care is exercised the rods may be placed as the forms are filled, whereby the use of separators can be dispensed with.

Since 1886 the C. & E. I. has been making its mile posts of concrete, 8 in. by 8 in., 8 ft. long, with white letters and figures depressed in a black background of colored mortar half an inch thick which is spread on the inside of the form at the proper location before filling the form with concrete. In some posts (perhaps 1/2 of 1 per cent) so much coloring was used that it rendered the face plate porous to such an extent that when it absorbed moisture in freezing weather the mortar would flake off after 4 to 10 yrs. of service. When the proper mixture was used no flaking occurred. When this method is used it facilitates the matter of painting as no stencils are required, but when posts have to be replaced the number or the location of the post must be known in order to cast the right figures and letters. Our present practice is to mold the post of plain concrete and after about 15 days paint on the surface a black background upon which can be stenciled the figures and letters 30 min. before shipping out. When shipping these posts we nail 1 in. by 3 in.

strips together and place over the corners, wrapping with wire in four places, which prevents breaking and scarring of the corners. These corner pieces are returned and used again for the same purpose.

Property line posts are made triangular with 5-in. faces, 6 ft. long, with recessed letters showing the road on two sides. No paint used on these posts.

Joint track division posts are made rectangular in section, 4 in. by 6 in., and 5 ft. long. Recessed letters 4 in. show the initials of the road and the reverse side the initials of the other road.

Our crossing sign posts are 6 in. square and 16 ft. long. The signs were formerly of cast iron weighing 145 lbs., with 5-in. by 5-in. cast socket tapered to 4 in. by 4 in., and 6 in. long attached to lower edge which fits down on the post. The posts are strengthened by a ¾-in. corrugated bar in the center.

Some of these signs, after being in service 12 yrs., have been removed by the section men and set up in another location, in as good condition as when made.

Our present highway crossing sign has two blades placed at angles of 45 deg. with the post, 1¼ in. thick, 11½ in. wide, and 6 ft. long. It is difficult to reinforce these properly on account of their size and they are easily broken, more so than if made of wood. Wood blades of this size will last 30 to 40 yrs., and for that reason are preferable to those of concrete.

In a few cases we have experienced more or less trouble on account of vandals destroying the corners on concrete posts. Posts should not be made with sharp corners but should be chamfered or rounded. Posts 8 in. by 8 in., 8 ft. long can be made of concrete for less than $1 each which are more economical than wooden posts.

The President:—A sign that I had in mind was one that was shown us on the way to the convention, at Needles, Cal., by the superintendent of the Santa Fe, within a block of the station. This highway crossing sign had concrete blades on a concrete post.

Mr. Elder:—I do not favor the concrete blades. They would be liable to be destroyed in our part of the country from being pelted with stones and used as targets by hunters and vandals. I believe that metal arms would give better service than those of concrete.

Mr. J. W. Wood:—The greatest objection to the concrete sign is that which was mentioned by Mr. Elder. The metal blades are far better. The shelling feature in the concrete sign is also objectionable. For that reason, also, the metal blades are better. The metal blades can be removed and sent in to the shop by the section men, for painting. This method is far better than that of having a gang of painters go over the road to paint the signs.

The cost of our concrete posts with metal blades is $4.17 as compared with $5.25 for the sign and post made entirely of wood. These costs were furnished by our stores department.

Mr. E. K. Barrett:—We are equipping our road with concrete whistle posts. We have already equipped the entire line with concrete mile posts which cost $1.55 each. The latter is a "V"-shaped post with depressed letters and figures on two sides, the depressions being filled with black cement. Trespassers have tried to damage the posts by shooting at them, but we have not yet lost a single post from that cause. The cost of the whistle post is 75 cts. They are 4 in. by 12 in. and 7½ ft. long, the mixture being in the proportion of 1:2:4. The reinforcing consists of 3 strands of Monarch reinforcing. We are using a concrete clearance post 6 in. by 6 in., 2 ft. long, which costs 25 cts. each.

I tried many combinations before I got a satisfactory black filling for the letters, finally using lamp black and cement. When I first tried this it smudged and the lamp black ran down the post. To overcome this we painted the letters over with Nile black. This prevents smudging and the depressed fillings that have been treated in this manner are in a satisfactory condition after ten years of service. (See illustrations page 232.)

Mr. A. H. King:—We are using a concrete monument on the Oregon Short Line to indicate the mileage. The numbers are stamped with a die near the top of the post; the post is square with the exception of a slight chamfer of perhaps ½ in.

Mr. Hadwen:—During the past summer we made a few experimental right-of-way monuments. They are about 3½ ft. in length and cost about 35 cts. each. They are reinforced on the four angles and the letters on top are made by means of an iron casting which is inserted in the form, producing sunken letters in the top of the post.

Mr. Staten:—We have a concrete mile post, 9 in. square and beveled at the top. When we first adopted the concrete post we

had some trouble in getting a letter that would stand. One of our painters uses apple vinegar. He paints the post and then allows it to stand a day or two after which he applies the lettering with black paint. We have had no trouble with our signs since using this method.

Mr. J. S. Robinson:—I suppose it is the acid that prevents peeling; acid of any kind would answer just as well.

Mr. G. H. Stewart:—The B. R. & P. has been using concrete posts since 1906. We make a T-shaped fence post 8 ft. long, 6 in. at the bottom and 4 in. at the top, reinforced with round steel, placed in the post about ½ in. from the outside. We do not leave any holes in the post. The fencing is fastened by tie wires reaching around the posts. These posts are made in molds in batteries of 30 with the flat side up, using a very wet mixture. The posts weigh 87½ lbs., the mixture being in the proportions of 1:2:4. Limestone ½ in. in size is used. The cost of the posts is 25 cts. each. Our mile posts are 8 ft. long, 5 in. thick, and 14 in. wide where three letters are used, and 12 in. wide for two letters (letters being 6 in. high). The reinforcing consists of ½-in. twisted steel.

Mr. Staten:—Our mile posts are made at the supervisor's headquarters. They are carefully loaded on a flat car and delivered to the place where they are to be used and are handled by means of a rail loader and a sling. The holes have been previously dug and the loader comes along, places the posts in the holes, and goes on to the next. In many cases the posts are painted before leaving the shop, but not always; sometimes they are set up and painted afterwards. I believe the latter method is the best as the painted posts are likely to be marred in handling. Posts must be protected when shipping singly, and carefully handled or they are liable to be broken.

Mr. Stewart:—I might add that our posts are slightly rounded on the corners. We do not crate them in shipping. They are loaded in box cars, being laid crosswise of the car, with boards under them. They are thrown off at the stations and delivered to the place where they are to be used by hand cars. The letters are made with an asphalt paint.

Mr. Barrett:—I just completed, this summer, a job of putting in 522 concrete mile posts. They were loaded on cars two tiers high. I sent a derrick car out to unload them as they weighed between 700 and 800 lbs. each. The posts were picked up with a

sling, placed in the hole, and the car moved to the next location. Out of the 522 posts that were placed only one was broken.

Mr. Hadwen:—Mr. Shope stated yesterday that on the Santa Fe they used rope to form the letters and figures and then molded the work right in the wall.

Mr. Shope:—I do not think there are any of us who have not been embarrassed a good many times by having someone ask the date of erection of structures. I think it is a very simple and economical method of putting it in the concrete as it is formed by using old or new rope, ½ in. or larger. One can form a very pretty letter or figure and place it in any position desired. The rope is tacked on the inside of the forms with small nails, and the cost is very slight.

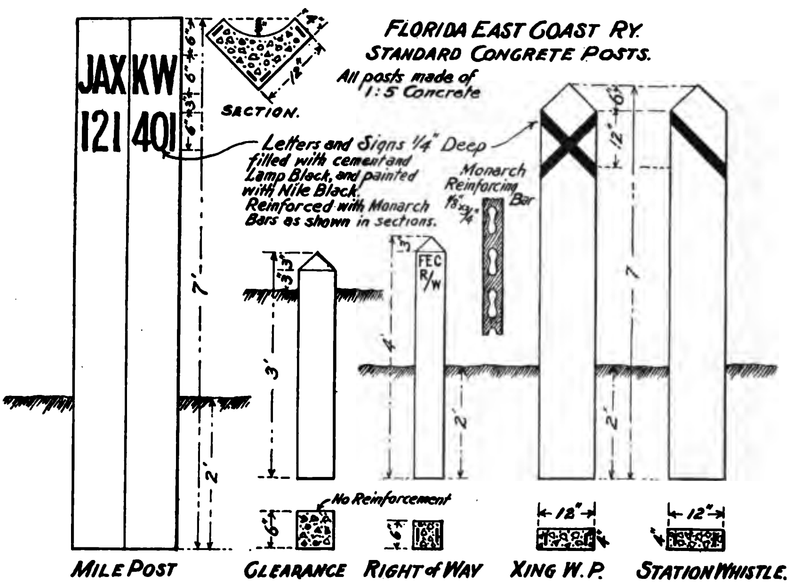
Mr. Hadwen:—On the Saint Paul, for the past 10 yrs., it has been the practice to place the date on the masonry, showing the year built. This is done by furnishing the crews with castings with the letters 6 in. high. These are put in the forms of the back walls when the abutments are erected, or at the crown of the arch in the case of an arch. The castings are not very expensive and at the end of the season are turned in as scrap and a new plate furnished for each succeeding year.

Mr. J. W. Wood:—We use a dating stamp for our culvert and bridge work. We simply have a carpenter cut the letters out of a piece of wood and this will answer for the entire season. At the end of the season we will have but one figure to make for the next year, in most cases. They are tacked on a board, 9 in. by 16 in.

Mr. Hadwen:—Our experience has shown that the cost of having a carpenter make the wooden signs would amount to more than the cost of making the castings in our shops. In the course of a season's work we would probably require 50 castings to take care of all the structures on the system. In the building of 300 structures each sign might be used probably a dozen times on culverts, track scale foundations, and various other structures.

Mr. Gehr:—We make concrete posts of various kinds. We find them very good and the only failures we had in the fence posts were caused by using them too soon after being made. Our end posts were only 6x6 at the top, and 8x8 at the bottom and proved to be too light, or not sufficiently reinforced. The braces were 5x5, 12 ft. long, well reinforced, and they proved to be all right. The posts were made in B. & A. molds and rein-

forced with a core of ⅝-in., 16-gage metal. The whistle posts are made 3 in. by 10 in., the letters being painted on the surface. It is our practice to paint all signs each year, and we have had no trouble due to the paint peeling off. We make mile posts in the same manner, reinforcing them and painting on the surface. Concrete rail rests, 6 in. by 12 in., are made in the same way.



Note: This Association received the title—American Railway Bridge and Building Association—at the 18th annual convention at Washington, D. C., October, 1908. Prior to that time it was called —Association of Railway Superintendents of Bridges and Buildings.

LIST OF ANNUAL CONVENTIONS.

No.	Place.	Date.	Membership.
1	St. Louis, Mo.,	Sept. 25, 1891.	60
2	Cincinnati, Ohio,	Oct. 18-19, 1892	112
3	Philadelphia, Pa.,	Oct. 17-19, 1893	128
4	Kansas City, Mo.,	Oct. 16-18, 1894	115
5	New Orleans, La.,	Oct. 15-16, 1895	122
6	Chicago, Ill.,	Oct. 20-22, 1896	140
7	Denver, Col.,	Oct. 19-21, 1897	127
8	Richmond, Va.,	Oct. 18-19, 1898	148
9	Detroit, Mich.,	Oct. 17-18, 1899	148
10	St. Louis, Mo.,	Oct. 16-18, 1900	143
11	Atlanta, Ga.,	Oct. 15-17, 1901	171
12	Minneapolis, Minn.,	Oct. 21-23, 1902	195
13	Quebec, Canada,	Oct. 20-22, 1903	223
14	Chicago, Ill.,	Oct. 18-20, 1904	293
15	Pittsburg, Pa.,	Oct. 17-19, 1905	313
16	Boston, Mass.,	Oct. 16-18, 1906	340
17	Milwaukee, Wis.,	Oct. 15-17, 1907	341
18	Washington, D. C.,	Oct. 20-22, 1908	368
19	Jacksonville, Fla.,	Oct. 19-21, 1909	393
20	Denver, Colo.,	Oct. 18-20, 1910	428
21	St. Louis, Mo.,	Oct. 17-19, 1911	499
22	Baltimore, Md.,	Oct. 15-17, 1912	524
23	Montreal, Que.,	Oct. 21-23, 1913	570
24	Los Angeles, Cal.,	Oct. 20-22, 1914	586

	1891-2.	1892-3.	1893-4.	1894-5.
President	O. J. Travis...	H. M. Hall......	J. E. Wallace....	Geo. W. Andrews
1st. V.-Pres. .	H. M. Hall.....	J. E. Wallace....	Geo. W. Andrews..	W. A. McGonagle.
2nd. V.-Pres.	J. B. Mitchell..	G. W. Hinman..	W. A. McGonagle.	L. K. Spafford.
3rd. V.-Pres.	James Stannard.	N. W. Thompson	L. K. Spafford....	James Stannard.
4th. V.-Pres. .	G. W. Hinman..	C. E. Fuller...	E. D. Hines......	Walter G. Berg.
Secretary	C. W. Gooch...	S. F. Patterson.	S. F. Patterson....	S. F. Patterson.
Treasurer	George M. Reid	George M. Reid.	George M. Reid..	George M. Reid.
Executive Members .	W. R. Damon.	G. W. Andrews.	Q. McNab	James Stannard.
	G. W. Markley.	J. M. Staten...	A. S. Markley....	James H. Travis.
	W. A. McGonagle	J. M. Caldwell.	Floyd Ingram.....	J. H. Cummin.
	G. W. McGehee.	Q. McNab......	James Stannard ..	R. M. Peck.
	G. W. Turner...	Floyd Ingram...	James H. Travis ..	J. L. White.
	J. E. Wallace..	A. S. Markley..	J. H. Cummin	A. Shane.

	1895-6.	1896-7.	1897-8.	1898-9.
President ...	W. A. McGonagle	James Stannard.	Walter G. Berg....	J. H. Cummin.
1st. V.-Pres. .	L. K. Spafford.	Walter G. Berg.	J. H. Cummin....	A. S. Markley.
2nd. V.-Pres.	James Stannard.	J. H. Cummin...	A. S. Markley....	C. C. Mallard.
3rd. V.-Pres.	Walter G. Berg.	A. S. Markley..	G. W. Hinman....	W. A. Rogers.
4th. V.-Pres. .	J. H. Cummin.	R. M. Peck....	C. C. Mallard.....	J. M. Staten.
Secretary ...	S. F. Patterson.	S. F. Patterson.	S. F. Patterson....	S. F. Patterson.
Treasurer	George M. Reid.	N. W. Thompson	N. W. Thompson..	N. W. Thompson.
Executive Members .	R. M. Peck...	W. O. Eggleston	G. J. Bishop......	Wm. S. Danes.
	J. L. White..	W. M. Noon...	C. P. Austin......	J. H. Markley.
	A. Shane	J. M. Staten...	M. Riney	W. O. Eggleston.
	A. S. Markley.	G. J. Bishop....	Wm. S. Danes....	R. L. Heflin.
	W. M. Noon...	C. P. Austin...	J. H. Markley....	F. W. Tanner.
	J. M. Staten...	M. Riney	W. O. Eggleston..	A. Zimmerman.

	1899-1900.	1900-1901.	1901-1902.	1902-1903.
President	Aaron S. Markley	W. A. Rogers....	W. S. Danes.....	B. F. Pickering.
1st. V.-Pres. .	W. A. Rogers...	W. S. Danes....	B. F. Pickering..	C. C. Mallard.
2nd. V.-Pres.	J. M. Staten....	B. F. Pickering..	A. Shane	A. Shane.
3rd. V.-Pres.	Wm. S. Danes...	A. Shane.......	A. Zimmerman ..	A. Zimmerman.
4th. V.-Pres. .	B. F. Pickering..	A. Zimmerman .	C. C. Mallard....	A. Montzheimer.
Secretary ...	S. F. Patterson..	S. F. Patterson.	S. F. Patterson..	S. F. Patterson.
Treasurer	N. W. Thompson	N. W. Thompson.	N. W. Thompson.	N. W. Thompson
Executive Members .	T. M. Strain....	T. M. Strain....	A. Montzheimer..	W. E. Smith.
	R. L. Heflin....	H. D. Cleaveland.	W. E. Smith.....	A. W. Merrick.
	F. W. Tanner...	F. W. Tanner..	A. W. Merrick...	C. P. Austin.
	A. Zimmerman...	A. Montzheimer.	C. P. Austin.....	C. A. Lichty.
	H. D. Cleaveland	W. E. Smith....	C. A. Lichty.....	W. O. Eggleston.
	A. Montzheimer.	A. W. Merrick..	W. O. Eggleston.	J. H. Markley.

	1903-1904.	1904-1905.	1905-1906.	1906-1907.
President	A. Montzheimer..	C. A. Lichty...	J. B. Sheldon....	J. H. Markley.
1st. V.-Pres. .	A. Shane	J. B. Sheldon..	J. H. Markley....	R. H. Reid.
2nd. V.-Pres.	C. A. Lichty....	J. H. Markley..	R. H. Reid.......	J. P. Canty.
3rd. V.-Pres.	J. B. Sheldon...	R. H. Reid.....	R. C. Sattley....	H. Rettinghouse.
4th. V.-Pres. .	J. H. Markley...	R. C. Sattley...	J. P. Canty......	F. E. Schall.
Secretary	S. F. Patterson..	S. F. Patterson..	S. F. Patterson..	S. F. Patterson.
Treasurer	C. P. Austin....	C. P. Austin....	C. P. Austin.....	C. P. Austin.
Executive Members .	R. H. Reid......	W. O. Eggleston	H. Rettinghouse .	W. O. Eggleston
	W. O. Eggleston	A. E. Killam....	A. E. Killam.....	A. E. Killam.
	A. E. Killam....	H. Rettinghouse.	J. S. Lemond.....	J. S. Lemond.
	R. C. Sattley....	J. S. Lemond...	C. W. Richey....	C. W. Richey.
	H. Rettinghouse..	W. H. Finley..	H. H. Eggleston.	H. H. Eggleston
	J. S. Lemond....	C. W. Richey...	F. E. Schall.....	B. J. Sweatt.

	1907-1908.	1908-1909.	1909-1910.	1910-1911.
President	R. H. Reid	J. P. Canty	J. S. Lemond	H. Rettinghouse
1st. V.-Pres.	J. P. Canty	H. Rettinghouse	H. Rettinghouse	F. E. Schall
2nd. V.-Pres.	H. Rettinghouse	F. E. Schall	F. E. Schall	A. E. Killam
3rd. V.-Pres.	F. E. Schall	J. S. Lemond	A. E. Killam	J. N. Penwell
4th. V.-Pres.	W. O. Eggleston	A. E. Killam	J. N. Penwell	L. D. Hadwen
Secretary	S. F. Patterson	S. F. Patterson	C. A. Lichty	C. A. Lichty
Treasurer	C. P. Austin	C. P. Austin	J. P. Canty	J. P. Canty
Executive Members	A. E. Killam	J. N. Penwell	W. Beahan	T. J. Fullem
	J. S Lemond	Willard Beahan	F. B. Scheetz	G. Aldrich
	C. W. Richey	F. B. Scheetz	L. D. Hadwen	P. Swenson
	T. S. Leake	W. H. Finley	T. J. Fullem	G. W. Rear
	W. H. Finley	L. D. Hadwen	G. Aldrich	W. O. Eggleston.
	J. N. Penwell	T. J. Fullem	P. Swenson	W. F. Steffens

	1911-1912.	1912-1913.	1913-1914.	1914-1915.
President	F. E. Schall	A. E. Killam	J. N. Penwell	L. D. Hadwen
1st. V.-Pres.	A. E. Killam	J. N. Penwell	L. D. Hadwen	G. Aldrich
2nd. V.-Pres.	J. N. Penwell	L. D. Hadwen	G. Aldrich	G. W. Rear
3rd. V.-Pres.	L. D. Hadwen	T. J. Fullem	G. W. Rear	C. E. Smith
4th. V.-Pres.	T. J. Fullem	G. Aldrich	C. E. Smith	E. B. Ashby
Secretary	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Treasurer	J. P. Canty	J. P. Canty	J. P. Canty	F. E. Weise
Executive Members	G. Aldrich	G. W. Rear	W. F. Steffens	W. F. Steffens
	P. Swenson	W. F. Steffens	E. B. Ashby	S. C. Tanner
	G. W. Rear	E. B. Ashby	S. C. Tanner	Lee Jutton
	W. F. Steffens	C. E. Smith	Lee Jutton	W. F. Strouse
	E. B. Ashby	S. C. Tanner	W. F. Strouse	C. R. Knowles
	W. O. Eggleston	Lee Jutton	C. R. Knowles	A. Ridgway

CONSTITUTION *

ARTICLE I.

NAME.

SECTION 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT.

SECTION 1. The object of this association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings and other structures, by investigation, reports and discussions, providing a medium for the exchange of ideas to the end that bridge and building practice may be systematized and improved.

SECTION 2. The association shall neither indorse nor recommend any particular devices, trade marks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussions unless the same have received the endorsement of the association in regular session.

ARTICLE III.

MEMBERSHIP.

SECTION 1. The membership of this association shall be divided into two classes—active and life members.

SECTION 2. To be eligible for active membership, a person must be actively employed in railway service in responsible charge of the design, construction or maintenance of railway bridges, buildings or other structures; a professor of engineering in a college or university of recognized standing; an engineering editor, or a government or private timber expert.

SECTION 3. To be eligible for life membership a person must have been a member of the association for at least five years and in general must have retired from active railway service. The association, however, may waive the latter condition by a majority vote of the members at a regular session for good and sufficient reasons. A life member shall have all the privileges of active membership and shall not be required to pay annual dues.

SECTION 4. Any member guilty of conduct unbecoming a railroad officer and a member of this association, or who shall refuse to comply with the rules of this association, may forfeit his membership on a two-thirds vote of the members present at any regular session of the association.

SECTION 5. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

*Revised October, 1914.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of this association shall be a president, four vice-presidents, a secretary, a treasurer and six executive members, all of whom shall constitute the executive committee.

SECTION 2. The past presidents of this association who continue to be members shall be entitled to be present at all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, nor shall their presence be requisite in order to constitute a quorum.

SECTION 3. Vacancies in any office for the unexpired term shall be filled by the executive committee without delay.

ARTICLE V.

EXECUTIVE COMMITTEE.

SECTION 1. The executive committee shall exercise a general supervision over the financial interests of the association, assess the amount of annual and other dues, call, prepare for and conduct general or special meetings and make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasury not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

SECTION 2. Two-thirds of the members of the executive committee may call special meetings, thirty days' notice being given members by mail.

SECTION 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE.

SECTION 1. Except as otherwise provided the officers shall be elected at the regular annual meeting of the association which convenes on the third Tuesday in October, and the election shall not be postponed except by unanimous consent of the members present at said annual meeting. The election shall be by ballot, a majority of the votes cast being required for election. Any active member of the association not in arrears for dues shall be eligible for office, but the president shall not be eligible for reëlection.

SECTION 2. The president, four vice-presidents, secretary and treasurer shall hold office for one year and the executive members for two years, three being elected each year. All officers will retain their offices until their successors are elected and installed.

Section 3. The term of office of the secretary may be terminated at any time by a two-thirds vote of the executive committee. His compensation shall be fixed by a majority vote of the executive committee. The secretary shall also serve as secretary of the executive committee.

SECTION 4. The treasurer shall be required to give bond in an amount to be fixed by the majority of the executive committee.

ARTICLE VII.

ANNUAL DUES.

SECTION 1. Every member upon joining the association shall pay to the secretary three dollars membership fee and two dollars per year in advance for annual dues. No member one year in arrears for dues shall be entitled to vote at any election, and any member more than one year in arrears shall be stricken from the list of members at the discretion of the executive committee.

ARTICLE VIII.

AMENDMENTS.

SECTION 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least sixty days previous to said regular meeting.

BY-LAWS*

TIME OF MEETING.

1. The regular meeting of this association shall convene annually on the third Tuesday in October at 10 a. m.

PLACE OF MEETING.

2. Places of holding the next annual convention may be proposed at any regular session of the association. All the places proposed shall be submitted to a ballot vote of the members present at the annual business session and the place receiving a majority of all votes cast shall be declared the location of the next annual meeting. If no place receives a majority of the votes cast, the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

4. It shall lie within the power of the executive committee to change the location of the meeting place if it becomes apparent that it is for the best interests of the association.

QUORUM.

5. At the regular meeting of the association, fifteen or more members shall constitute a quorum.

DUTIES OF OFFICERS.

6. The president shall have general supervision over the affairs of the association. He shall preside at all meetings of the association and of the executive committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall, with the sec-

*Revised October, 1914.

retary, sign all contracts or other written obligations of the association which have been approved by the executive committee. At the annual meeting the president shall present a report containing a statement of the general condition of the association.

7. The vice-presidents in order of seniority shall preside at meetings in the absence of the president and discharge his duties in case of a vacancy in his office.

8. It shall be the duty of the secretary to keep a correct record of proceedings of all meetings of this association; to keep correct all accounts between this association and its members; to collect all moneys due the association, and pay the same over to the treasurer, taking his receipt therefor, and to perform such other duties as the association may require.

9. The treasurer shall receive all moneys and deposit the same in the name of the association and shall receipt to the secretary therefor. He shall invest all funds not needed for current disbursements as shall be ordered by the executive committee. He shall pay all bills, when properly certified and approved by the president, and make such reports as may be called for by the executive committee.

NOMINATING COMMITTEE.

10. After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year, which shall prepare a list of names of nominees for officers to be voted on at the next annual convention, in accordance with Article VI of the constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making further nominations.

AUDITING COMMITTEE.

11. At the first session of each annual meeting the president shall appoint a committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary and treasurer and certify as to the correctness of their accounts. Acceptance of this committee's report will be regarded as the discharge of the committee.

COMMITTEE ON SUBJECTS FOR DISCUSSION.

12. After the annual meeting the president shall appoint a committee whose duty it shall be to prepare a list of subjects for investigation to be submitted for approval at the next convention.

COMMITTEES ON INVESTIGATION.

13. After the association has adopted the list of subjects for investigation the president for the succeeding year shall appoint the committees who shall prepare the subjects for report and discussion. He may also appoint individual members to prepare reports on special subjects, or to report on any special or particular subject.

PUBLICATION COMMITTEE.

13. After each annual meeting the executive committee shall appoint a publication committee consisting of three active members whose duty it shall be to coöperate with the secretary in the issuing of the publications of the association. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year.

ORDER OF BUSINESS.

14. 1st—Registration of members.
2nd—Reading minutes of the last meeting.
3rd—Admission of new members.
4th—President's address.
5th—Reports of secretary and treasurer.
6th—Payment of annual dues.
7th—Appointment of special committees.
8th—Reports of standing committees.
9th—Unfinished business.
10th—New business.
11th—Election of officers and selection of place for holding next annual meeting.
12th—Installation of officers.
13th—Adjournment.

(Report of nominating committee to be read at first session of second day—Section 10 of By-Laws.)

DECISIONS.

15. The votes of a majority of the members present shall decide any question, motion or resolution which shall be brought before the association, unless otherwise provided.

DISCUSSIONS.

16. All discussions shall be governed by Robert's rules of order.

DIRECTORY OF MEMBERS

Aagaard, P., Chief Inspector, I. C. R. R., Chicago.
Aldrich, Grosvenor, Supvr. B. & B., N. Y. N. H. & H. R. R., Boston.
Alexander, W. E., Supt. B. and B., B. & A. R. R., Houlton, Me.
Allard, E. E., For. B. & B., Mo. Pac. Ry., St. Louis.
Anderson, August, Gen'l For. B. and B., L. S. & I. Ry., Marquette, Mich.
Anderson, L. J., For. B. and B., C. & N. W. Ry., Escanaba, Mich.
Andrews, G. W., Asst. to Eng. M. of W., B. & O. R. R., Baltimore, Md.
Andrews, O. H., Supt. B. and B., St. J. & G. I. Ry., St. Joseph, Mo.
Andrews, T. O., Gen. For. B. & B., L. E. & W. R. R., Tipton, Ind.
Archbold, H. L., Asst. Engr., Sou. Pac. Co., Los Angeles, Cal.
Arey, R. J., 541 So. Cummings St., Los Angeles, Cal.
Arnold, F. J., Gen. For. B. & B., D. L. & W. R. R., Scranton, Pa.
Ashby, E. B., Chief Engr., L. V. R. R., New York City.
Ashton, D. H., C. E., Care Utah Const. Co., Ogden, Utah.
Astrue, C. J., Asst. Engr., Sou. Pac. Co., San Francisco.
Auge, E. J., Chief Carp., C. M. & St. P. Ry., Wells, Minn.
Austin, C. P., 107 Park St., Medford, Mass.

Bach, C. F., For. B. & B., C. & N. W. Ry., Belle Plaine, Iowa.
Bailey, F. W., Res. Engr., G. H. & H. R. R., Galveston, Texas.
Bailey, S. D., Div. For. of Buildings, M. C. R. R., Detroit, Mich.
Ball, E. E., Engr. Const., A. T. & S. F. Ry., Winslow, Ariz.
Ballenger, D. A., Roadmaster, Southern Ry., Greenville, S. C.
Baluss, F. C., Engr. B. & B., D. M. & N. Ry., Duluth, Minn.
Barnes, O. F., Div. Engr., Erie R. R., Jersey City, N. J.
Barr, Robt., Pocatello, Idaho.
Barrett, E. K., Supvr. B. and B., F. E. C. Ry., St. Augustine, Fla.
Barrett, J. E., Supt. of Track, B. and B., L. & H. R. Ry., Warwick, N. Y
Barton, M. M., Master Carp., P. R. R., West Philadelphia, Pa.
Bates, Onward, Civil Engineer, McCormick Bldg., Chicago.
Beahan, Willard, Asst. Engr., L. S. & M. S. Ry., Cleveland, Ohio.
Beal, F. D., 912 Yeon Bldg., Portland, Ore.
Bean, C. C., Contractor, 243 Benton St., Freeport, Ill.
Beard, A. H., For. Carp., P. & R. Ry., Reading. Pa.
Beckman, B. F., Engr., F. S. & W. R. R., Fort Smith, Ark.
Beeson, R. W., Div. For. B. and B., C. & S. Ry., Trinidad, Colo.
Bender, Henry, For. B. & B., C. & N. W. Ry., Eagle Grove. Ia.
Bentele, Hans, Asst. Ch. Engr., Nat. Rys. of Mex., Mexico City, Mex.
Berry, J. S., Supvr. B. and B., S. L. S. W. Ry., St. Louis, Mo.
Bibb, J. M., Supvr. B. and B., L. & N. R. R., Birmingham, Ala.
Bigelow, F. M., Supv. B. & B., S. P. L. A. & S. L. R. R., Salt Lake City
Bishop, McClellan, Mast. Carp., C. R. I. & P. Ry., El Reno, Okla.
Bishop, R. R., For. B. and B., S. P. L. A. & S. L. R. R., Salt Lake City.
Biss, C. H., Engr., New Zealand Govt. Rys., Christchurch, N. Z.
Black, J. D., Supvr. B. and B., P. M. R. R., Saginaw, Mich.

Blackwell, J. H., Roadmaster, Sou. Ry., Columbia, S. C.
Blowers, S. H., For. Carp., B. & O. R. R., Columbus, O.
Bohland, J. A., Br. Engr., G. N. Ry., St. Paul, Minn.
Bonner, J. K., Asst. Supvr. B. & B., N. Y. C. & H. R. R., Rochester, N. Y.
Bouton, W. S., Engr. of Bridges, B. & O. R. R., Baltimore Md.
Bowers, Stanton, Mast. Carp., P. C. C. & St. L. Ry., Bradford, O.
Bowers, S. C., Mast. Carp. of Brdgs., P. C. C. & St. L. Ry., Steubenville, O.
Bowman, A. L., Ch. Engr. Dept. of Bridges, New York City.
Bowman, R. M., Asst. Engr., L. E. & W. R. R., Indianapolis, Ind.
Boyd, G. E., Div. Engr., D. L. & W. R. R., Buffalo, N. Y.
Brantner, Z. T., Supt. M. of W. Shops, B. & O. R. R., Martinsburg, W. Va.
Bratten, T. W., Supvr., B. and B., S. P. Co., Oakland Pier, Cal.
Brewer, W. A.
Bricker, H. R., Inspr. M. of W., B. & O. R. R., Baltimore, Md.
Briggs, B. A., Supt. Streets, Colorado Springs, Colo.
Brown, Alf., B. & B. Inspr., P. E. Ry., Los Angeles, Cal.
Browne, J. B., Gen'l For. B. and B., K. C. C. & S. Ry., Clinton, Mo.
Browne, J. S., Asst. Engr., N. Y. N. H. & H. R. R., New Haven, Conn.
Bruce, R. J., Supt. Bldgs., M. P. Ry., St. Louis, Mo.
Buck, A. J., Chief Carpenter, C. M. & St. P. Ry., Tacoma, Wash.
Bulger, Hugh, For. B. & B., Sou. Pac. Co., Oakland Pier, Cal.
Burgess, W. H., Supvr. B. & B., Sou. Pac. Co., Stockton, Cal.
Burke, Daniel, Supvr. B. and B., Sou. Pac. Co., Tucson, Ariz.
Burkhalter, F. L., Supt. Sou. Pac. Co., Portland, Ore.
Burnett, W. L., For. B. & B., St. L. I. M. & S. Ry., Eudora, Ark.
Burns, W. E., Div. Engr., Corvallis & Eastern R. R., Albany, Ore.
Burpee, Moses, Chief Engr., B. & A. R. R., Houlton, Maine.
Burrell, F. L., Gen'l For. B. and B., C. & N. W. Ry., Fremont, Neb.
Byrd, L. J., For. B. & B., St. L. I. M. & S. Ry., Dermott, Ark.

Cahill, E., Genl. For. B. & B., D. L. & W. R. R., Binghamton, N. Y.
Cahill, M. F., Contractor, 1641 Market St., Jacksonville, Fla.
Cahill, P. W., Foreman, N. & W. R. R., Roanoke, Va.
Caldwell, J. M., Insp. B. and B., C. I. & L. Ry., Lafayette, Ind.
Caldwell, J. T., For. B. & B., Sou. Pac. Co., Bakersfield, Cal.
Camp, W. M., Editor, Railway Review, Chicago, Ill.
Canty, J. P., Supvr. B. and B., B. & M. R. R., Fitchburg, Mass.
Cardwell, W. M., Mast. Carp., W. T. Co., Washington, D. C.
Carmichael, Wm., St. J. & G. I. R. R., St. Joseph, Mo.
Carpenter, J. T., Princeton, Ind.
Carter, E. M., Supvr. B. and B., T. C. R. R., Nashville, Tenn.
Case, F. M., For. W. S., C. & N. W. Ry., Belle Plaine, Ia.
Casey, W. W., For. B. & B., K. C. S. Ry., Texarkana, Texas.
Catchot, A. J., Supvr. B. & B., L. & N. R. R., Ocean Springs, Miss.
Cayley, W., Supvr., G. T. Ry., Stratford, Ont.
Christy, B. B., Br. For., S. A. L. Ry., Tallahassee, Fla.
Clark, J. H., Asst. Engr., Sou. Pac. Co., Los Angeles, Cal.
Clark, W. A., Chief Engr., D. & I. R. R. R., Duluth. Minn.
Clark, W. M., Mast. Carp., B. & O. R. R., Pittsburgh, Pa.
Clopton, A. S., Supt. B. & B., M. K. & T. Ry., Parsons, Kans.
Clothier, E. E., Chief Carp., C. M. & St. P. Ry., Malden, Wash.
Cole, J. E., Gen'l Inspr., Sou. N. E. Ry., Providence, R. I.
Conn, F. J., Supvr. B. & B., C. N. O. & T. P. Ry., Lexington, Ky.
Connolly, C. G., Gen. For. B. & B., D. L. & W. R. R., Scranton, Pa.
Connor, R. E., Supvr. B. & B., Southern Ry., Columbia, S. C.
Cookson, D. M., Asst. Engr., Burma Ry. Extn. Kalaw, Burma, India.
Coombs, R. D., Engr. and Contr., 30 Church St., New York City.
Cooper, H. A., Roadmaster, T. I. Ry., Gananoque, Ont.
Corbin, W. S., For. B. and B., Sou. Pac. Co., Los Angeles.
Corey, S. T., Ch. Dftsman, Br. Dept., C. R. I. & P. Ry., Chicago.

Cota, G. M., Ch. Clerk, Eng. Dept., C. Vt. Ry., St. Albans, Vt.
Crites, G. S., Asst. Engr., Sou. Pac. Co., Tucson, Ariz.
Crosman, D. M., Asst. Engr., Sou. Pac. Co., Los Angeles, Cal.
Cullen, J. F., For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Cummin, Joseph H., Bay Shore, N. Y.
Cunningham, A. O., Chief Engr., Wabash R. R., St. Louis, Mo.
Curtin, William, Contractor, Govan, Saskatchewan.

Dale, Wm. C., For. W. S., O. S. L. R. R., Pocatello, Idaho.
Dalstrom, O. F., Ch. Dftsman, Br. Dept., C. & N. W. Ry., Chicago.
Danes, W. S., Engr. M. of W., Wabash R. R., Peru, Ind.
Davis, C. H., Civil Engineer, 18 Old Slip, New York City.
Dawley, W. S., 5657 Cabanne Ave., St. Louis, Mo.
Decker, H. H., Contractor, 1707 Pleasant St., Des Moines, Ia.
Degnan, L. V., 1834 Hearst Ave., Berkeley, Cal.
Derr, W. L., Supt., C. G. W. R. R., Clarion, Iowa.
Develin, R. G., Asst. Engr. M. of W., P. R. R., Philadelphia, Pa.
DeWitt, H. R., Asst. Engr., Mo. Pac. Ry., Little Rock, Ark.
Dickson, Geo., For. Brdgs., Sou. Pac. Co., Oakland, Cal.
Dodd, A. M., Brazil Ry., Sao Paulo, Brazil, S. Am.
Donaldson, C. E., Actg. G. F. B. & B., C. Vt. R. R., St. Albans, Vt.
Douglass, H. S., Supvr. B. & B., Sou. Ry., Charleston, S. C.
Drake, R. M., M. of W. Asst., Sou. Pac. Co., San Francisco, Cal.
Draper, F. O., Supt. of Bridges, I. C. R. R., Chicago.
Draper, I. A., Steel Erec. For., O. S. L. R. R., Pocatello, Idaho.
Drum, H. R., Chief Carp., C. M. & St. P. Ry., Mitchell, S. D.
Dupree, James, For. W. S., C. T. H. & S. E. Ry., Crete, Ill.
Durfee, T. H., For. B. and B., C. & N. W. Ry., Huron, S. D.

Eastman, J. S., Idaho Falls, Idaho.
Easton, G. A., Scale Insp., Sou. Pac. Co., West Oakland, Cal.
Edinger, F. S., C. E., Hansford Bldg., San Francisco, Cal.
Edwards, W. R., Sr. Struct. Engr., I. C. C., Washington, D. C.
Eggers, C. H., Mast. Carp., C. R. I. & P. Ry., Little Rock, Ark.
Eggleston, H. H., Supvr. B. & B., C. G. W. R. R., Des Moines, Ia.
Eggleston, W. O., Insp. of Bridges, Erie R. R., Huntington, Ind.
Elder, W. E., Mast. Carp., C. B. & Q. R. R., Burlington, Iowa.
Elliott, R. O., Supvr. B. and B., L. & N. R. R., Nashville, Tenn.
Elwell, H. A., Supvr. B. & B., C. G. W. Ry., Clarion, Ia.
Ettinger, C., Gen. Ptr. For., I. C. R. R., Chicago.
Ewart, John, Spvr. Water Service, B. & M. R. R., Boston, Mass.

Fake, C. H., Ch. Engr., M. R. & B. T. R. R., Bonne Terre, Mo.
Fellows, C. W., For. W. S., C. & S. Ry., Denver, Colo.
Ferdina, A. H., For. B. & B., St. L. I. M. & S. Ry., St. Louis.
Ferris, B. F., For. B. and B., Sou. Pac. Co., Los Angeles.
Findley, A., 929 Wash. Ave., Portland, Me.
Finley, W. H., Ch. Engr., C. & N. W. Ry., Chicago.
Fisher, J. F., Bridge Inspr., Sou. Pac. Co., Sacramento, Cal.
Fisher, Morris, Supvr. B. & B., Sou. Pac. Co., Ogden, Utah.
Fisk, C. H., Cons. Engr., 1232 Oakley Place, St. Louis, Mo.
Fletcher, Jr., J. W., Roadmaster, Car. & N. W. Ry., Chester, S. C.
Flint, C. F., For. B and B., C. V. R. R., St. Albans, Vt.
Floren, E. R., Roadmaster, C. R. I. & P. Ry., Rock Island, Ill.
Flynn, M. J., For. B. and B., C. & N. W. Ry., Chicago.
Forbes, John, Bridge Engr., **45 Victoria Road, Halifax, N. S.**
Forsgren, Oscar, Brigham, Utah.
Fowlkes, J. R., Roadmaster, Southern Ry., Columbia, S. C.
Fraser, Alex., Supvr. B. & B., Sou. Pac. Co., Bakersfield, Cal.
Fraser, James, Ch. Engr., N. S. W. Govt. Rys., Sydney, N. S. W.

Fraser, Neil, Gen'l Br. For., Sou. Pac. Co., Mayfield, Cal.
Frazier, W. C., Supvr. B. and B., S. P. L. A. & S. L. Ry., Los Angeles.
Fritz, Phil., For. B. & B., Sou. Pac. Co., Los Angeles.
Froese, Julius, Gen. For. B. & B., A. T. & S. F. Ry., LaJunta, Colo.

Gagnon, Ed., Supvr. B. and B., M. & St. L. R. R., Minneapolis, Minn.
Gaskin, W., Scale Inspr., Sou. Pac. Co., Los Angeles, Cal.
Gaut, J. B., Supt. B. & B., G. T. Ry., Chicago.
Gehr, B. F., Mast. Carp., P. C. C. & St. L. Ry., Richmond, Ind.
Gentis, Ira, B. and B. Foreman, Sou. Pac. Co., Oakland, Cal.
George, E. C., Supvr. B. and B., G. C. & S. F. Ry., Beaumont, Tex.
George, W. J., Bay Road, Claremont, W. Australia.
Giesing, August, Supt. B. and B., C. R. R. R., Houghton, Mich.
Giusto, Peter, For. B. & B., Sou. Pac. Co., San Francisco.
Given, J. A., Asst. Div. Engr., Sou. Pac. Co., Sacramento, Cal
Gnadt, C., Br. For., St. L. I. M. & S. Ry., Poplar Bluff, Mo.
Gokey, J. C., For. Water Service, G. T. Ry., Richmond, Que.
Goldmark, Henry, C. E., 270 W. 94th St., New York City.
Gooch, C. W., 1325 W. 9th St., Des Moines, Ia.
Goodale, L. F., Supvr. Engr., P. I. Commission, Manila, P. I.
Gooding, Jr., W. J., Div. Engr., S. A. L. Ry., Jacksonville, Fla.
Gordon, Guy, For. Water Service, C. R. I. & P. Ry., Little Rock, Ark.
Graham, F. M., Asst. Engr., C. & N. W. Ry., Boone, Iowa.
Graham, Wm., C. E., 3027 Windsor Ave., Baltimore, Md.
Gratto, James, Asst. Engr., S. P. Co., Los Angeles, Cal.
Graves, Lon, For. B. & B., St. L. I. M. & S. Ry., Dermott, Ark.
Green, C. F., Supvr. B. and B., Sou. Pac. Co., Sacramento, Cal.
Green, E. H. R., Pres., Texas Midland R. R., Terrell, Tex.
Greiner, J. E., Civil Engineer, 605 Continental Bldg., Baltimore, Md.
Griffith, F. M., Supvr. B. and B., C. & O. Ry., Covington, Ky.
Grover, J. H., Gen. For. W. S., A. T. & S. F. Ry., Needles, Cal.
Grover, O. L., Asst. Engr., C. & O. Ry., Richmond, Va.
Guild, Edward, Supvr. B. and B., P. M. R. R., Grand Rapids, Mich.
Guire, W. A., For. B. & B., St. L. I. M. & S. Ry., Lake Providence, La.
Guppy, B. W., Engr. Structures, B. & M. R. R., Boston, Mass.
Guretzky, J., For. B. and B., Col. Mid. Ry., Colorado City, Colo.

Hadwen, L. D., Engr. Masy. Const., C. M. & St. P. Ry., Chicago, Ill.
Hall, N. L., Supvr. B. & B., Sou. Ry., Greensboro, N. C.
Hall, Thomas, Asst. Supt. Bldgs., M. C. R. R., Jackson, Mich.
Hampton, H. A., Asst. Div. Engr., Sou. Pac. Co., Portland, Oregon.
Hand, Geo. W., Valuation Engr., C. & N. W. Ry., Chicago.
Hanks, G. E., Supvr. B. and B., P. M. R. R., East Saginaw, Mich.
Hansen, Robt., Carp. For., Sou. Pac. Co., West Oakland, Cal.
Hargrove, J. C., For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.
Harman, H. H., Engr. of Brs., B. & L. E. R. R., Greenville, Pa.
Harman, Wm. C., Br. Inspr., Sou. Pac. Co., Bakersfield, Cal.
Harris, C. J., For. B. and B., O. S. L. R. R., Roberts, Idaho.
Harris, W. B., Roadmaster, S. A. & A. P. Ry., Yoakum, Tex.
Hartley, James, Supvr. B. and B., N. P. Ry., Staples, Minn.
Harvey, E. H., St. L. I. M. & S. Ry., Montrose, Ark.
Hausgen, W., Supvr. B. and B., M. P. Ry., Sedalia, Mo.
Henderson, J., Foreman B. and B., G. T. Ry., St. Thomas, Ont.
Henderson, R., For. W. S., B. & O. R. R., Garrett, Ind.
Herrig, C., For. W. S., C. & N. W. Ry., Wall Lake, Iowa.
Higgins, H. K., Cons. Engr., 209 McBride St., Jackson, Mich.
Hill, H. R., Asst. Supvr. B. & B., L. & N. R. R., Birmingham, Ala.
Hinchee, J. M., For. B. & B., Sou. Pac. Co., Los Angeles, Cal.

Hitesman, U. S., Gen. For., N. Y. C. & H. R. R. R., New York City.
Hofecker, Peter, Supvr. B. and B., L. V. R. R., Auburn, N. Y.
Holcomb, J. W., Supvr. B. & B., L. V. R. R., Buffalo, N. Y.
Holdridge, H. D., Supvr. B. and B., Y. & M. V. R. R., Vicksburg, Miss.
Hopke, W. T., Mast. Carp., B. & O. R. R., Grafton, W. Va.
Horning, H. A., Supt. of Bldgs., M. C. R. R., Jackson, Mich.
Horth, A. J., Mast. Carp., Erie R. R., Meadville, Pa.
Howe, J. H., Civil Engineer, Cresco, Iowa.
Howson, E. T., Eng. Editor, Railway Age Gazette, Chicago, Ill.
Hubbard, A. B., Cambridge, Mass.
Hudson, B. M., Gen. For. B. & B., T. & B. V. Ry., Teague, Tex.
Hull, K. S., Supt., G. C. & S. F. Ry., Temple, Tex.
Humbert, A. T., For. B. & B., B. & O. R. R., Pittsburgh, Pa.
Hume, E. S., Deputy Com'r., W. A. Govt. Rys., Perth, W. Australia.
Hunciker, John, For. Bridge Erection, C. & N. W. Ry., Chicago.
Hurst, Walter, Inspector, C. B. & Q. Ry., Chicago, Ill.
Hutchens, J. A., Bridge Insp., Sou. Pac. Co., Ogden, Utah.

Ingalls, F., Supvr. B. and B., N. P. Ry., Jamestown, N. D.
Ingram, Floyd, Supvr. B. and B., L. & N. R. R., Erin, Tenn.
Irwin, J. W., For. B. & B., C. & N. W. Ry., Chadron, Neb.

Jack, H. M., Gen'l For. B. and B., I. & G. N. R. R., Palestine, Tex.
James, A. J., Gen. For. B. & B., A. T. & S. F. Ry., Topeka, Kans.
James, Harry, Gen'l For. B. and B., C. & S. Ry., Denver, Col.
Jardine, Hugh, Asst. Engr., Intercolonial Ry., Moncton, N. B.
Jennings, Geo. H., Asst. Ch. Engr., E. J. & E. Ry., Joliet, Ill.
Jensen, C. A., For. B. & B., Sou. Pac. Co., Los Angeles, Cal.
Jewell, J. O., Supt. B. and B., C. T. H. & S. E. Ry., Terre Haute, Ind.
Johnson, Phelps, Pres. St. Lawrence Bridge Co., Montreal, Que.
Johnston, C. E., Ch. Engr., K. C. Sou. Ry., Kansas City, Mo.
Johnston, J. H., Supt. B. & B., G. T. Ry., Montreal, Que.
Jonah, F. G., Chief Engr., St. L. & S. F. R. R., St. Louis, Mo.
Joslin, Judson, Genl. For. B. & B., L. V. R. R., Auburn, N. Y.
Jutton, Lee, Div. Engr., C. & N. W. Ry., Madison, Wis.

Keefe, D. A., Consulting Engr., Athens, Pa.
Keith, H. C., Civil Engineer, 116 Nassau St., New York City.
Kelly, C. W., Peoples Gas Building, Chicago.
Kemp, A. E., For. B. & B., L. V. R. R., Hazleton, Pa.
Kibbey, G. S., Asst. Engr., M. & St. L. R. R., Minneapolis, Minn.
Killam, A. E., 84 Highfield St., Moncton, N. B.
Killian, J. A., Res. Engr., Sou. Ry., Charlotte, N. C.
King, A. H., Supvr. B. and B., O. S. L. R. R., Pocatello, Idaho.
King, C. F., Div. Engr., C. & N. W. Ry., Omaha, Neb.
King, F. E., Dist. Carp., C. M. & St. P. Ry., Minneapolis, Minn.
Kinney, G. W., Inspr. B. & B., D. & R. G. R. R., Salt Lake City.
Kinzie, H. H., Supvr. B. and B., N. Y. N. H. & H. R. R., Taunton, Mass.
Klumpp, G. J., Supvr. Bridges, N. Y. C. & H. R. R. R., Rochester, N. Y.
Knapp, F. A., Mast. Carp., Erie R. R., Jersey City, N. J.
Knowles, C. R., Gen. For. Water Works, I. C. R. R., Chicago.
Krausch, W. T., Engr. Bldgs., C. B. & Q. R. R., Chicago, Ill.
Krutsinger, M. R., Supvr. B. & B., W. Pac. Ry., Sacramento, Cal.

Lacy, J. D., Insp., S. A. & A. P. Ry., Morgan City, La.
Lacy, W. J., For. B. & B., St. L. I. M. & S. Ry., Poplar Bluff, Mo.
La Fountain, N. H., Asst. Supt. of B. and B., C. M. & St. P. Ry., Chicago.
Lamb, C. W., For. B. & B., St. L. I. M. & S. Ry., Pine Bluff, Ark.
Land, G. W., Supvr. B. and B., St. L. I. M. & S. Ry., McGehee, Ark.

Lane, E. G., Dist. Engr. M. of W., B. & O. R. R., Cincinnati, O.
Large, H. M., Mast. Carp., G. R. & I. Ry., Fort Wayne, Ind.
Larsen, A., Res. Engr., S. N. E. R. R., Millville, Mass.
Larson, John, Room 608, 537 So. Dearborn St., Chicago.
Lawrence, P. P., Asst. Supvr. B. & B., L. E. & W. R. R., Tipton, Ind.
Layfield, E. N., C. E., 513 Transportation Building, Chicago.
Leake, T. S., Contractor, 6433 Kenmore Ave., Chicago.
Leavitt, F. J., For. B. and B., B. & M. R. R., Salem, Mass.
Lee, Frank, Prin. Asst. Engr., C. P. R., Winnipeg, Manitoba.
Lemond, J. S., Engr., M. of W., Southern Ry., Charlotte, N. C.
Leonard, H. R., Engr. B. and B., P. R. R., Philadelphia, Pa.
Lichty, C. A., Gen'l Insp., C. & N. W. Ry., Chicago.
Linehan, T. J., Ventura, Cal.
Little, J. W., Asst. Supvr., B. & B., L. & N. R. R., Birmingham, Ala.
Lloyd, F. F., C. E., 1871 Sacramento St., San Francisco, Cal.
Lodge, Harry, For. B. & B., Sou. Pac. Co., Tracy, Cal.
Loftin, E. L., Supvr. B. and B., Q. & C. Ry., Vicksburg, Miss.
Long, M. A., Asst. to Ch. Engr., B. & O. R. R., Baltimore, Md.
Lorch, J. A., Asst. Engr., C. & N. W. Ry., Chicago.
Loughery, E., Gen'l For. B. and B., T. & P. Ry., Marshall, Tex.
Loughnane, George, Div. Engr., C. & N. W. Ry., Escanaba, Mich.
Loweth, C. F., Ch. Engr., C. M. & St. P. Ry., Chicago.
Lydston, W. A., 105 Norfolk Ave., Swampscott, Mass.
Lyman, C. R., For. Brgs., C. Vt. Ry., Waterbury, Vt.

Mace, B. S., Supt. of Insurance, B. & O. R. R., Baltimore, Md.
Mackenzie, W. B., R. of W. Engr., Intercolonial Ry., Moncton, N. B.
Macy, E. C., Supt. Const., Stone & Webster Eng. Corpn., 620 Perkins Bldg., Tacoma, Wash.
Mahan, Wm., Mast. Carp., W. & L. E. R. R., Canton, Ohio.
Malloy, J. B., For. B. & B., Sou. Pac. Co., San Francisco.
Mann, J. M., Gen'l For. B. and B., Ft. W. & D. C. Ry., Ft. Worth, Tex
Manning, M. G., Supvr. W. S., C. G. W. R. R., Ft. Dodge, Iowa.
Manthey, G. A., Asst. Supt. B. & B., Soo Line, Minneapolis, Minn.
Marcy, C. A., For. B. and B., C. & N. W. Ry., Chicago.
Markley, A. S., Mast. Carp., C. & E. I. R. R., Danville, Ill.
Markley, J. H., Mast. B. and B., T. P. & W. Ry., Peoria, Ill.
Marsh, John, For. B. and B., B. & M. R. R., Lawrence, Mass.
Maruyama, Y., C. E., Sou. Manchuria Ry., Dairen, Japan.
Massenburg, W. G., Div. Engr., G. C. & S. F. Ry., Beaumont, Tex.
Mathews, J. D., Div. Engr., Sou. Pac. Co., Tucson, Ariz.
Matthews, W. H., Mast. Carp., Erie R. R., Hornell, N. Y.
Mattos, F. D., Supt. Pres. Wks., S. P. Co., W. Oakland, Cal.
May, A. D., Asst. Engr., Mo. Pac. Ry., Little Rock, Ark.
Mayer, M. J., Ch. Draftsman, Sou. Pac. Co., San Francisco, Cal.
McCandless, C. W., For. B. & B., Sou. Pac. Co., Ventura, Cal
McCann, E., Gen. For. B. and B., A. T. & S. F. Ry., Wellington, Kans.
McCaulley, S. W., C. E., 6106 Kenwood Ave., Chicago, Ill.
McCloy, A. L., For. B. & B., P. M. R. R., Reese, Mich.
McCormick, R. S., Ch. Engr., A. C. & H. B. R., Sault Ste. Marie, Ont.
McCoy, W. H., Asst. Engr., Sou. Pac. Co., Dunsmuir, Cal.
McCue, G. C., Gen. Supvr. B. & B., G. T. Ry., Ottawa, Ont.
McCully, C. S., Gen'l For. B. and B., N. P. Ry., Jamestown, N. D.
McFadden, T. E., Chief Carp., C. M. & St. P. Ry., Cedar Falls, Wash.
McGee, Danl., For. B. & B., Sou. Pac. Co., Sacramento, Cal.
McGonagle, W. A., Pres., D. M. & N. Ry., Duluth, Minn.
McIlwain, J. T., Mast. Carp., B. & O. R. R., Akron, Ohio.
McIntosh, Wm., Hydr. Engr., A. C. R. R., Taneres, Rosario, Argentina.
McIver, B. T., Supvr. B. and B., D. & I. R. R. R., Two Harbors, Minn.
McKee, D. L., For. B. and B., P. & L. E. R. R., McKee's Rocks, Pa.

McKee, H. C., Insp. of Iron Bridges, C. of G. R. R., Macon, Ga.
McKee, R. J., Supvr. B. and B., I. C. R. R., Freeport, Ill.
McKeel, W. S., Mast. Carp., G. R. & I. Ry., Grand Rapids, Mich.
McKibben, Robert, Mast. Carp., P. R. R., Altoona, Pa.
McLean, Neil, Mast. Carp., Erie R. R., Huntington, Ind.
McLeod, Angus M., For. B. & B., Sou. Pac. Co., Oakland, Cal.
McMahon, J., Supvr. B. & B., G. T. Ry., Belleville, Ont.
McNab, A., Supvr. B. and B., P. M. R. R., Holland, Mich.
McQueen, A., Gen. For. Brs., D. L. & W. R. R., Binghamton, N. Y.
McRae, D. A., Carp. For., C. P. R., Lethbridge, Alberta.
McVay, A. B., Supvr. B. and B., L. & N. R. R., Evansville, Ind.
Mellgren, J., For. W. S., C. & N. W. Ry., Eagle Grove, Iowa.
Meloy, E. S., Asst. Engr., C. M. & St. P. Ry., Chicago.
Mercier, A. T., Div. Engr., Sou. Pac. Co., Los Angeles, Cal.
Merrick, A. W., Contractor, Boone, Ia.
Meyer, H. W., Asst. Struct. Engr., G. T. Ry., Montreal, Que.
Meyers, W. F., For. B. and B., C. & N. W. Ry., Boone, Iowa.
Miller, A. F., Mast. Carp., Penn. Lines W. of Pitts., Chicago.
Miller, J. W., Archt., C. & N. W. Ry., Chicago.
Mills, R. P., Supvr. Bldgs., N. Y. C. & H. R. R. R., New York City.
Mitchell, G. A., Supt. B. and B., G. T. Ry., Toronto, Ont.
Moen, J. D., Supt. B. & B., C. St. P. M. & O. Ry., St. Paul, Minn.
Montzheimer, A., Ch. Engr., E. J. & E. Ry., Joliet, Ill.
Moore, E. G., For. Carpenter, B. & O. R. R., Flatwoods, W. Va.
Moore, W. H., Eng. of Brgs., N. Y. N. H. & H. R. R., New Haven, Conn.
Morrison, E. C., Div. Engr., Sou. Pac. Co., San Francisco.
Mountain, G. A., Ch. Engr., Ry. Com. of Canada, Ottawa, Ont.
Mountfort, Albert, Supvr. B. and B., B. & M. R. R., Nashua, N. H.
Munson, S. P., Chief Clerk, I. C. R. R., Mattoon, Ill.
Murphy, J. J., For. Water Service, Sou. Pac. Co., Oakland, Cal.
Murray, J. R., Supvr. B. & B., A. G. S. R. R., Tuscaloosa, Ala.
Murray, Edwd., Asst. Engr. B. & B., C. M. & St. P. Ry., Miles City, Mont.
Musgrave, C. T., For. B. & B., O. S. L. R. R., Idaho Falls, Idaho.
Musser, D. G., Mast. Carp., Penn. Lines W. of Pitts., Wellsville, Ohio.

Nelson, J. C., Engr. M. of W., S. A. L. Ry., Norfolk, Va.
Nelson, O. T., Supt. M. of W., A. & W. P. R. R., Atlanta, Ga.
Nelson, P. N., Gen'l For. of Carp., S. P. Co., San Francisco, Cal.
Newton, R., For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Noon, W. M., 617 Ave. G., Miami, Fla.
Nuelle, J. H., Chief Engr., N. Y. O. & W. R. R., Middletown, N. Y.

O'Connor, W. F., Supvr. Bridges, L. I. R. R., Flushing, N. Y.
O'Neill, P. J., Mast. Carp., L. S. & M. S. Ry., Adrian, Mich.
Osborn, F. C., Consulting Engineer, 740 Engineer's Bldg., Cleveland, O.

Page, A. A., Div. For. B. & B., B. & M. R. R., Lowell, Mass.
Parker, J. F., Gen. For. B. & B., A. T. & S. F. Ry., San Bernardino, Cal.
Parker, W. V., Parker Const. Co., Faxon, Tenn.
Parks, J., 3347 Boulevard F., Denver, Colo.
Parsons, P. E., For. B. & B., O. S. L. R. R., Salt Lake City.
Patterson, S. F., Secretary Emeritus, Concord, N. H.
Pauba, A. W., For. B. and B., C. & S. Ry., Denver, Colo.
Peabody, K., Asst. Supv. Bldgs., N. Y. C. & H. R. R. R., New York City.
Penwell, J. N., Supvr. B. and B., L. E. & W. Ry., Tipton, Ind.
Perkins, H. D., 1501 Walnut St., Danville, Ill.
Pettis, W. A., Gen'l Supvr. of Buildings, N. Y. C. & H. R. R. R., Rochester, N. Y.
Phillips, B. P., Asst. Supvr. B. and B., N. Y. N. H. & H. R. R., Willimantic, Conn.

Pickering, B. F., Supvr. B. & B., B. & M. R. R., Salem, Mass.
Pickering, F. M., Div. For. B. & B., B. & M. R. R., Salem, Mass.
Pinson, J. F., Asst. Engr. B. & B., C. M. & St. P. Ry., Seattle, Wash.
Plank, D. E. Supvr. B. and B., Pac. Elec. Ry., Los Angeles, Cal.
Pollard, Harry, Asst. Gen'l Br. Insp., S. P. Co., San Francisco, Cal.
Pollard, Homer, Bridge Inspr., Sou. Pac. Co., West Oakland, Cal.
Pollock, H. H., Mast. Carp. of Bldgs., P. C. C. & St. L. Ry., Carnegie, Pa.
Porter, L. H., Box 35, Andover, Conn.
Potts, J. O., M. of W. Inspr., B. & O. R. R., Baltimore, Md.
Powell, C. E., Genl. Insp. Brgs., C. & O. Ry., Hinton, W. Va.
Powell, S. J., Div. For. B. & B., O. S. L. R. R., Ogden, Utah.
Powers, G. F., Contractor, Joliet, Ill.
Proctor, V. C., Gen'l For. B. and B., A. T. & S. F. Ry., Winslow, Ariz.

Quinn, William, Supt. B. & B., St. L. S. W. Ry., of T., Tyler, Tex.

Rand, F. C., Somerville, Mass.
Rankin, W. F., Mast. Carp., Pa. Lines West, Cambridge, Ohio.
Ranney, J. E., Genl. For. B. & B., D. L. & W. R. R., Buffalo, N. Y.
Rask, A. G., Suptr. B. & B., C. St. P. M. & O. Ry., Altoona, Wis.
Ratliff, W. L., Supvr. B. & B., I. C. R. R., Chicago, Ill.
Rear, G. W., Gen'l Insp., S. P. Co., San Francisco, Cal.
Redfield, J. A. S., Div. Engr., C. & N. W. Ry., Fond du Lac, Wis.
Redinger, C. A., Res. Engr., Sou. Ry., Knoxville, Tenn.
Redmond, C. E., Supvr. B. & B., St. L. I. M. & S. Ry., Van Buren, Ark.
Reid, R. H., Supvr. Bridges, L. S. & M. S. Ry., Cleveland, Ohio.
Reid, Wm., Timber Insp., I. C. R. R., Grenada, Miss.
Replogle, J. S., For. B. & B., Sou. Pac. Co., Oakland, Cal.
Rettinghouse, H., Ch. Engr., C. St. P. M. & O. Ry., St. Paul, Minn.
Reynolds, A. L., Inspr., L. V. R. R., New York City.
Reynolds, A. W., Genl. For., Carp. & Ptrs., P. R. R., New York City.
Reynolds, J. V., For. B. & B., St. L. I. M. & S. Ry., Dermott, Ark.
Rice, A. P., Roadmaster, C. N. & L. R. R., Columbia, S. C.
Rich, B. D., Painter For., Sou. Pac. Co., Stockton, Cal.
Richardson, R. W., Div. Engr., C. & N. W. Ry., Sioux City, Ia.
Ridgway, Arthur, Asst. Ch. Engr., D. & R. G. R. R., Denver, Colo.
Riney, M., Gen'l For. B. and B., C. & N. W. Ry., Baraboo, Wis.
Rintoul, D. T., Gen'l For. B. and B., Sou. Pac. Co., Bakersfield, Cal.
Robertson, A. A., Supr. B. and B., N. W. Pac. Ry., San Rafael, Cal.
Robinson, A. L., Br. Inspr., Sou. Pac. Co., Stockton, Cal.
Robinson, A. W., Asst. Engr., O. S. L. R. R., Salt Lake City.
Robinson, J. S., Div. Engr., C. & N. W. Ry., Chicago.
Robinson, John, Supvr. B. and B., P. M. R. R., Grand Rapids, Mich.
Robinson, R. B., Asst. Engr., O. S. L. R. R., Pocatello, Idaho.
Rodman, G. A., Supt. B. & B., N. Y. N. H. & H. R. R., New Haven, Conn.
Rogers, W. A., Civil Engineer, 37 W. Van Buren St., Chicago.
Rohbock, W. L., Ch. Engr., W. & L. E. R. R., Cleveland, Ohio.
Rose, Norman, Supvr. B. and B., Sou. Pac. Co., Portland, Ore.
Rose, W. M., For. Water Service, Sou. Pac. Co., Sacramento, Cal.
Ross, William, Chief Carp., C. M. & St. P. Ry., Millbank, S. D.
Rounseville, D., Eng. Maint., C. & N. W. Ry., Chicago.
Roy, C. M., Gen. Bridge For., L. & N. R. R., Birmingham, Ala.
Ruge, Aug., Supvr. B. & B., C. St. P. M. & O. Ry., Mankato, Minn.
Rykenboer, E. J., Supvr. Bldgs., N. Y. C. & H. R. R., Rochester, N. Y.

Salisbury, J. W., Gen. For. D. & W., A. C. L. R. R., Port Tampa, Fla.
Sampson, G. T., Asst. Engr., N. Y. N. H. & H. R. R., Boston.
Sattley, R. C., Valuation Engr., C. R. I. & P. Ry., Chicago.
Scannell, D. W., For. B. & B., S. P. L. A. & S. L. R. R., Salt Lake City.
Schall, F. E., Bridge Engr., L. V. R. R., So. Bethlehem, Pa.

Scheetz, F. B., Dept. Valuation, I. C. C., Kansas City, Mo.
Schoolcraft, C. H., For. Brgs., C. Vt. R., Farnham, Que.
Schuessler, W. B., Supvr. B. & B., N Y N H & H R. R., Waterbury, Conn.
Scott, Chas., Supvr. B. & B., B. R. & P. Ry., E. Salamanca, N. Y.
Scribner, C. J., Bldg. Inspr., C. B. & Q. Ry., Chicago.
Searls, Niles, Gen. Fire Inspector, Sou. Pac. Co., San Francisco, Cal.
Sedmoradsky, C., Asst. For. B. & B., C. St. P. M. & O. Ry., Altoona, Wis.
Sedwell, G. W., Tunnel For., Sou. Pac. Co., Bakersfield, Cal.
Seeley, L. T., For. B. & B., A. T. & S. F. Ry., Needles, Cal.
Seely, S. A., Supvr. B. & B., N. Y. C. & H. R. R., Watertown, N. Y.
Selig, A. C., Ch. Archt., Intercolonial Ry., Moncton, N. B.
Shane, A., 417 Merchants Loan & Trust Bldg., Chicago.
Shanklin, F. E., Gen. For., C. & N. W. Ry., Belle Plaine, Iowa.
Sharpe, D. W., Supv. B. & B., N. Y. N. H. & H. R. R., New Haven, Conn.
Sharpe, T. E., Supvr. B. and B., Sou. Ry., Greenville, S. C.
Sheldon, J. B., Supvr. B. and B., N. Y. N. H. & H. R. R., Providence, R. I.
Sheldon, W. W., For. B. & B., Sou. Pac. Co., Oakland, Cal.
Sheley, Wm., Asst. Supvr. B. and B., L. & N. R. R., Evansville, Ind.
Shope, D. A., Gen'l For. B. and B., A. T. & S. F. Ry., Fresno, Cal.
Shropshire, W., Supvr. of B. and B., Y. & M. V. R. R., Greenville, Miss.
Sibley, C. A., Engr. & Contr., 902 Chapel St., New Haven, Conn.
Siefer, F. M., Ch. Engr., Corvallis & Eastern R. R., Portland, Ore.
Simmons, I. L., Br. Engr., C. R. I. & P. Ry., Chicago.
Sisson, F. P., Asst. Engr., G. T. Ry., Detroit, Mich.
Skeoch, Jas., Gen. For. B. & B., D. L. & W. R. R., Dunmore, Pa.
Smith, C. E., Chief Engr., Mo. Pac. Ry. Sys., St. Louis.
Smith, C. W., Asst. Supvr. B. & B., Sou. Pac. Co., Portland, Ore.
Smith, E. U., Asst. Engr., W. & L. E. R. R., Cleveland, O.
Smith, G. W., American Bridge Co., Chicago.
Smith, L. D., 2082 Grove St., Oakland, Cal.
Smith, M. A., Gen. For. B. & B., I. C. R. R., New Orleans, La.
Snow, J. P., 1120 Kimball Bldg., Boston, Mass.
Snyder, A. C., D. & R. G. R. R., Salt Lake City, Utah.
Soisson, J. L., Gen'l For. B. and B., L. S. & M. S. Ry., Norwalk, Ohio.
Soles, G. H., Supt. B. and B., P. & L. E. R. R., Pittsburgh, Pa.
Spencer, C. H., Asst. Dist. Engr., I. C. C., Washington, D. C.
Spencer, Jos., For. B. & B., G. T. Ry., Stratford, Ont.
Spencer, William, Gen'l For. B. and B., C. & N. W. Ry., Norfolk, Neb.
Stamler, H., Supvr. B. & B., L. & N. R. R., Paris, Ky.
Stannard, James, 1602 Broadway, Kansas City, Mo.
Staten, J. M., Gen'l Bridge Insp., C. & O. Ry., Richmond, Va.
Steffens, W. F., Special Engr., N. Y. C. Lines, New York City.
Stelle, C. A.
Stern, I. F., C. E., Old Colony Bldg., Chicago.
Stevens, A. R., For. B. and B., O. S. L. R. R., Pocatello, Idaho.
Stewart, G. H., Master Mason, B. R. & P. Ry., Salamanca, N. Y.
Stewart, W A., For. Brgs., C. Vt. R. R., New London, Conn.
Stewart, W. G., Supvr. B. and B., L. & N. R. R., Nashville, Tenn.
Storck, E. G., Mast. Carp., P. & R. Ry., Philadelphia, Pa.
Strouse, W. F., Asst. Engr., B. & O. R. R., 400 Forest Road, Baltimore.
Stuart, H. B., Struct. Engr., G. T. Ry., Montreal, Que.
Stuart, T. J., Supvr. B. and B., W. Pac. Ry., Elko, Nev.
Sullivan, William, Care Div. Engr., Mo. Pac. Ry., Kansas City, Mo.
Suter, O. M., Supvr. B. & B., I. C. R. R., Chicago.
Swain, G. F., Prof. C. E., Harvard University, Cambridge, Mass.
Swallow, W. A., Ch. Engr., Ga. & Fla. Ry., Augusta, Ga.
Swan, L. W., Supvr. B. and B., L. V. R. R., Easton, Pa.
Swartz, A., Vice Pres., Toledo & Western R. R., Sylvania, Ohio.
Swartz, H. C., Master B. & B., G. T. R., St. Thomas, Ont.
Sweeney, Wm., For. B and B., C. & N. W. Ry., Green Bay, Wis.

Swenson, P., Supt. B. and B., M. St. P. & S. Ste. M. Ry., Minneapolis.
Sydell, A. C., Chief Draftsman, C. B. & Q. R. R., Chicago, Ill.

Talbott, J. L., Gen'l For. B. and B., A. T. & S. F. Ry., Pueblo, Col.
Tanner, F. W., Insp. M. of W., Mo. Pac. Ry., St. Louis, Mo.
Tanner, S. C., Mast. Carp., B. & O. R. R., Baltimore, Md.
Tattershall, E. R., Supvr. B. & B., N. Y. C. & H. R. R. R., Malone, N. Y.
Taylor, D. B., Mast. Carp., B. & O. R. R., Garrett, Ind.
Taylor, F. A., Mast. Carp., B. & O. R. R., Cumberland, Md.
Taylor, Herbert, Supvr. B. and B., D. & R. G. R. R., Alamosa, Colo.
Taylor, J. C., Supvr. B. and B., N. P. Ry., Glendive, Mont.
Taylor, J. J., Supt. B. & B., K. C. S. Ry., Texarkana, Tex.
Teaford, J. B., Supvr. B. & B., Sou. Ry., Louisville, Ky.
Templin, E. E., For. Carp., P. & R. Ry., Pottsville, Pa.
Thomas, C. E., Contractor, Mt. Pulaski, Ill.
Thomas, T. E., Mast. Carp., B. & O. R. R., Wilmington, Del.
Thompson, C., Supt. B. and B., E. J. & E. Ry., Joliet, Ill.
Thompson, C. S., Supt. B. and B., D. & R. G. R. R., Denver.
Thompson, E. E., G. F. B. & B., A. E. R. R., Phœnix, Ariz.
Thompson, F. L., Asst. Ch. Engr., I. C. R. R., Chicago.
Thompson, H. C., Div. Engr., N. Y. C. & H. R. R. R., Weehawken, N. J.
Thompson, J. L., Supvr. B. & B., D. & R. G. R. R., Salt Lake City, Utah.
Thorn, J. O.
Tichbourne, W. H., Supvr. B. & B., G. T. Ry., London, Ont.
Toohey, J. E., Gen'l For. B. and B., P. M. R. R., Grand Rapids, Mich.
Trapnell, Wm., V. P. & G. M., H. S. R. R., Romney, W. Va.
Tratman, E. E. R., Editor, Eng. News, Monadnock Blk., Chicago, Ill.
Travis, J. E., Bridge Dept., I. C. R. R., Chicago, Ill.
Travis, J. H., Kansas City Term., Kansas City, Mo.
Tretheway, Thos., For. B. & B., Sou. Pac. Co., Stockton, Cal.
Troup, G. A., Engr., Govt. Rys., Wellington, N. Z.
Tyers, W. J., Supvr., G. T. Ry., Ottawa, Ont.

Ullery, O. E., Asst. Engr., C. & N. W. Ry., Sioux City, Ia.
Urbutt, C. F., Asst. Engr., C. M. & St. P. Ry., Chicago, Ill.

Van Auken, A. M., Inspr. Maint., C. R. I. & P. Ry., Joliet, Ill.
Vance W. H., Engr. M. of W., La. & Ark. Ry., Stamps, Ark.
Vandegrift, C. W., C. & O. Ry., Lock Box 258, Alderson, W. Va.
Vaughan, James, Supvr. B. and B., D. & R. G. R. R., Salida, Colo.
Vincent, E. J., For. B. & B., Sou. Pac. Co., Los Angeles.

Wackerle, L. J., Supvr. B. & B., Mo. Pac. Ry., Osawatomie, Kans.
Wagner, R., Gen. For. B. & B., M. & N. A. R. R., Harrison, Ark.
Waits, A. L., For. B. and B., St. L. I. M. & S. Ry., St. Louis, Mo.
Walker, I. O., Asst. Engr., N. C. & St. L. Ry., Paducah, Ky.
Wallenfelsz, J., Mast. Carp., Pa. Lines W., Cambridge, O.
Walther, C. H., Supvr. B. & B., Mo. Pac. Ry., Poplar Bluff, Mo.
Warcup, C. F., For. W. S., G. T. R., St. Thomas, Ont.
Watson, P. N., Supvr. B. and B., Maine Central R. R., Brunswick, Me
Wehlen, Charles, Br. Inspr., L. I. R. R., Jamaica, N. Y.
Weise, F. E., Chief Clerk, Eng. Dept., C. M. & St. P. Ry., Chicago.
Weldon, A., For. B. & B., Sou. Pac. Co., Los Angeles, Cal.
Welker, G. W., Supvr. B. and B., Southern Ry., Alexandria, Va.
Wells, A. A., R. M. and Supvr. B. & B., Sou. Ry., Winston-Salem, N. C.
Wells, D. T., For. B. and B., O. S. L. R. R., Salt Lake City, Utah.
Wells, L. N., Div. For., B. & M. R. R., Concord, N. H.
Wenner, E. R., Supvr. B. and B., L. V. R. R., Ashley, Pa.
Wester, C. A., Div. Engr., Sou. Pac. Co., Dunsmuir, Cal.
Wheaton, L. H., Div. Engr., Intercolonial Ry., Dartmouth, N. S.

White, G. W., Engr. Const., Sou. Ry., Charlotte, N. C.
White, I. F., Engr. M. of W., C. G. W. R. R., Chicago.
White, J. B., For. W. S., C. & N. W. Ry., Boone, Ia.
Whiting, B. F., El Paso, Tex.
Whitney, W. C., Asst. Fld. Engr., I. C. C., 51 Hobson St., Brighton, Mass.
Wicks, Warren, Gen'l For., L. I. R. R., Amityville, N. Y.
Wilkinson, J. M., Supvr. B. and B., C. N. R. R., Van Wert, Ohio.
Wilkinson, W. H., Bridge Insp., Erie R. R., Elmira, N. Y.
Williams, Arthur, Engr., W. & M. Ry., Wellington, N. Z.
Williams, J. C., Supvr. B. and B., A. & W. P. Ry., Opelika, Ala.
Williams, M. R., Gen. For. B. & B., A. T. & S. F. Ry., Las Vegas, N. M.
Wilson, E. E., Supvr. of Bridges, N. Y. C. & H. R. R. R., New York City (81 E. 125th St.).
Wilson, J., Supvr. B. & B., G. T. Ry., Hamilton, Ont.
Wilson, M. M. Div. Br. Inspr., Sou. Pac. Co., Los Angeles
Wilson, W. W., Div. Engr., G. C. & S. F. Ry., Galveston, Tex.
Winter, J. L., Mast. Carp., S. A. L. Ry., Waldo, Fla.
Wise, E. F., 207 Clay St., Waterloo, Iowa.
Witt, C. C., Dist. Engr., I. C. C., 1020 McGee St., Kansas City, Mo.
Wolf, A. A., Dist. Carp., C. M. & St. P. Ry., Milwaukee, Wis.
Wood, J. P., Supvr. B. & B., P. M. R. R., Saginaw, Mich.
Wood, J. W., Gen'l For. B. and B., A. T. & S. F. Ry., Needles, Cal.
Wood, W. E., Dist. Engr., C. M. & St. P. Ry., Chicago.
Wright, C. W., Mast. Carp., L. I. R. R., Jamaica, N. Y.
Wright, G. A., Ill. Traction System, Decatur, Ill.

Yappen, Adolph, Dist. Carp., C. M. & St. P. Ry., Chicago.
Yereance, W. B., Cons. Engr., 128 Broadway, New York City.
Young, R. C., Chief Engr., L. S. & I. Ry., Marquette, Mich.

Zinsmeister, E. C., Mast. Carp., B. & O. R. R., Zanesville, O.
Zook, D. C., Mast. Carp., Pa. Lines W. of Pitts., Ft. Wayne, Ind.

Total number of members, 588.

LIFE MEMBERS.

Austin, C. P., 107 Park St., Medford, Mass.
Carmichael, Wm., St. J. & G. I. R. R., St. Joseph, Mo.
Carpenter, J. T., Sou. Ry., Princeton, Ind.
Cummin, Jos. H., Bay Shore, N. Y.
Findley, A., 929 Wash. Ave., Portland, Me.
Forbes, Jno., 45 Victoria Road, Halifax, N. S.
Gooch, C. W., 1325 W. 9th St., Des Moines, Ia.
Green, E. H. R., Texas Midland R. R., Terrell, Tex.
Hanks, G. E., E. Saginaw, Mich.
Hubbard, A. B., B. & M. R. R., Boston, Mass.
Killam, A. E., Moncton, N. B.
Lydston, W. A., Swampscott, Mass.
McLean, Neil, Mast. Carp., Erie R. R., Huntington, Ind.
Mountain, G. A., Ch. Engr., Ry. Com. of Canada, Ottawa, Ont.
Noon, W. M., Miami, Fla.
Parks, Jas., U. P. R. R., Denver, Colo.
Patterson, S. F. (Sec. Emeritus), Concord, N. H.
Porter, L. H., Box 35, Andover, Conn.
Ross, Wm., C. M. & St. P. Ry., Millbank, So. Dak.
Snow, J. P., 1120 Kimball Bldg., Boston, Mass.
Stannard, Jas., 1602 Broadway, Kansas City, Mo.
Tanner, Frank, Mo. Pac. Ry., St. Louis, Mo.
Vandegrift, C. W., C. & O. Ry., Alderson, W. Va.
Wise, E. F., 207 Clay St., Waterloo, Ia.

DECEASED MEMBERS.

Amos, A.,
Berg, Walter G.
Bishop, Geo. J.
Blair, J. A.
Brady, James
Carr, Charles
Causey, T. A.
Cleaveland, H. D.
Costolo, J. A.
Crane, Henry
DeMars, James
Dunlap, H.
Fletcher, H. W.
Foreman, John
Fuller, C. E.
Gilbert, J. D.
Gilchrist, E. M.
Graham, T. B.
Hall, H. M.
Harwig, W. E.
Heflin, R. L.
Henson, H. M.
Hinman, G. W.
Holmes, H. E.
Hubley, John
Humphreys, Thos.
Isadell, L. S.
Johnson, J. E.
Keen, Wm. H.
Lantry, J. F.
Large, C. M.
Larson, G.
Lovett, J. W.
Mallard, C. C.
Markley, Abel S.
McCormack, J. W.
McGehee, G. W.
McIntyre, Jas.
Mellor, W. J.
Millner, S. S.
Mitchell, J. B.
Mitchell, W. B.
Morgan, J. W.
Morgan, T. H.
Morrill, H. P.
Peck, R. M.
Perry, W. W.
Phillips, H. W.
Powell, W. T.
Reid, G. M.
Renton, Wm.
Reynolds, E. F.
Robertson, Daniel
Schaffer, J.
Schenck, W. S.
Schwartz, J. C.
Spafford, L. K.
Spangler, J. A.
Spaulding, E. C.
Spencer, C. F.
Taylor, J. W.
Thompson, N. W.
Tozzer, Wm. S.
Trautman, J. J.
Travis, O. J.
Van Der Hoek, J.
Wallace, J. F.
Walden, W. D.
Welch, E. T.
Wells, J. M.
Wood, W. B.
Worden, C. G.

MEMBERSHIP AND MILEAGE OF RAILWAYS REPRESENTED.

Name of Road and Membership.	Members.	Mileage.
Alabama, Great Southern R. R.,	1	361
J. R. Murray, Tuscaloosa, Ala.		
Algoma Central & Hudson Bay Ry.	1	232
R. S. McCormick, Sault Ste. Marie, Ont.		
Arizona Eastern R. R.	1	355
E. E. Thompson, Phœnix, Ariz.		
Atchison, Topeka & Santa Fé Ry.,	5	5,968
Julius Froese, La Junta, Colo.		
A. J. James, Topeka, Kans.		
E. McCann, Wellington, Kans.		
John L. Talbott, Pueblo, Colo.		
M. R. Williams, Las Vegas, N. M.		
Atchison, Topeka & Santa Fé Ry. (Coast Lines)	7	2 022
E. E. Ball, Winslow, Ariz.		
J. H. Grover, Needles, Cal.		
J. F. Parker, San Bernardino, Cal.		
V. C. Proctor, Winslow, Ariz.		
L. T. Seeley, Needles, Cal.		
D. A. Shope, Fresno, Cal.		
J. W. Wood, Needles, Cal.		
Atlanta & West Point R. R. and W. Ry. of Ala.	2	225
O. T. Nelson, Atlanta, Ga.		
J. C. Williams, Opelika, Ala.		
Atlantic Coast Line R. R.	1	4,500
J. W. Salisbury, Port Tampa, Fla.		
Baltimore & Ohio R. R. (System)	21	4,738
G. W. Andrews, Baltimore, Md.		
S. H. Blowers, Columbus, O.		
W. S. Bouton, Baltimore, Md.		
Z. T. Brantner, Martinsburg, W. Va.		
H. R. Bricker, Baltimore, Md.		
W. M. Clark, Pittsburgh, Pa.		
R. Henderson, Garrett, Ind.		
W. T. Hopke, Grafton, W. Va.		
A. T. Humbert, Pittsburgh, Pa.		
E. G. Lane, Cincinnati, O.		
M. A. Long, Baltimore, Md.		
B. S. Mace, Baltimore, Md.		
J. T. McIlwain, Akron, O.		

Name of Road and Membership.	Members.	Mileage
Baltimore & Ohio R. R. (System). Continued.		
E. G. Moore, Grafton, W. Va.		
J. O. Potts, Baltimore, Md.		
W. F. Strouse, Baltimore, Md.		
S. C. Tanner, Baltimore, Md.		
D. B. Taylor, Garrett, Ind.		
F. A. Taylor, Cumberland, Md.		
T. E. Thomas, Wilmington, Del.		
E. C. Zinsmeister, Zanesville, O.		
Bangor & Aroostook R. R.	2	628
W. E. Alexander, Houlton, Me.		
M. Burpee, Houlton, Me.		
Bessemer & Lake Erie R. R.	1	210
H. H. Harman, Greenville, Pa.		
Boston & Maine R. R.	14	2,288
Cyrus P. Austin (retired), Medford, Mass.		
J. P. Canty, Fitchburg, Mass.		
John Ewart, Boston, Mass.		
B. W. Guppy, Boston, Mass.		
Andrew B. Hubbard (retired), Boston, Mass.		
F. J. Leavitt, Salem, Mass.		
William A. Lydston (retired), Swampscott, Mass.		
John Marsh, Lawrence, Mass.		
Albert Mountfort, Nashua, N. H.		
A. A. Page, Lowell, Mass.		
S. F. Patterson (retired), Concord, N. H.		
B. F. Pickering, Salem, Mass.		
F. M. Pickering, Salem, Mass.		
L. N. Wells, Concord, N. H.		
Brazil Ry.,	1	10,000
A. M. Dodd, Sao Paulo, Brazil, S. A.		
Buffalo, Rochester & Pittsburgh Ry.,	2	586
Chas. Scott, E. Salamanca, N. Y.		
G. H. Stewart, E. Salamanca, N. Y.		
Canadian Pacific Ry.	2	11,641
Frank Lee, Winnipeg, Man.		
D. A. McRae, Lethbridge, Alberta.		
Carolina & Northwestern Ry.	1	133
J. W. Fletcher, Jr., Chester, S. C.		
Central of Georgia Ry.	1	1,916
H. C. McKee, Macon, Ga.		
Central Vermont Ry.,	6	536
G. M. Cota, St. Albans, Vt.		
C. Donaldson, St. Albans, Vt.		
C. F. Flint, St. Albans, Vt.		
C. R. Lyman, Waterbury, Vt.		
C. H. Schoolcraft, Farnham, Que.		
W. A. Stewart, New London, Conn.		
Chesapeake & Ohio Ry.,	5	2,062
F. M. Griffith, Covington, Ky.		
Oscar L. Grover, Richmond, Va.		

Name of Road and Membership.	Members.	Mileage
Chesapeake & Ohio Ry. Continued.		
C. E. Powell, Hinton, W. Va.		
J. M. Staten, Richmond, Va.		
C. W. Vandegrift, Alderson, W. Va.		
Chicago & Eastern Illinois R. R.	1	1,266
A. S. Markley, Danville, Ill.		
Chicago & North Western Ry.,	32	8,090
L. J. Anderson, Escanaba, Mich.		
C. F. Bach, Belle Plaine, Ia.		
H. Bender, Eagle Grove, Ia.		
F. L. Burrell, Fremont, Neb.		
F. M. Case, Belle Plaine, Ia.		
O. F. Dalstrom, Chicago, Ill.		
T. H. Durfee, Huron, S. D.		
W. H. Finley, Chicago, Ill.		
M. J. Flynn, Chicago, Ill.		
F. M. Graham, Boone, Ia.		
G. W. Hand, Chicago, Ill.		
C. Herrig, Wall Lake, Ia.		
John Hunciker, Chicago, Ill.		
Lee Jutton, Madison, Wis.		
C. F. King, Omaha, Neb.		
C. A. Lichty, Chicago, Ill.		
J. A. Lorch, Chicago, Ill.		
George Loughnane, Escanaba, Mich.		
C. A. Marcy, Chicago, Ill.		
J. Mellgren, Eagle Grove, Ia.		
W. F. Meyers, Boone, Iowa.		
J. W. Miller, Chicago, Ill.		
J. A. S. Redfield, Fond du Lac, Wis.		
R. W. Richardson, Sioux City, Ia.		
M. Riney, Baraboo, Wis.		
J. S. Robinson, Chicago, Ill.		
D. Rounseville, Chicago, Ill.		
F. E. Shanklin, Belle Plaine, Ia.		
Wm. Spencer, Norfolk, Nebr.		
W. M. Sweeney, Green Bay, Wis.		
O. E. Ullery, Sioux City, Ia.		
J. B. White, Boone, Ia.		
Chicago, Burlington & Quincy R. R.,	5	9,129
W. E. Elder, Burlington, Ia.		
W. Hurst, Chicago, Ill.		
W. T. Krausch, Chicago, Ill.		
C. J. Scribner, Chicago.		
A. C. Sydell, Chicago, Ill.		
Chicago Great Western R. R.,	5	1,496
W. L. Derr, Clarion, Ia.		
H. H. Eggleston, Des Moines, Ia.		
H. A. Elwell, Clarion, Ia.		
M. G. Manning, Ft. Dodge, Ia.		
I. F. White, Chicago, Ill.		
Chicago, Indianapolis & Louisville Ry.	1	578
J. M. Caldwell, Lafayette, Ind.		

Name of Road and Membership.	Members.	Mileage
Chicago, Milwaukee & St. Paul Ry.,	18	9,612
E. J. Auge, Wells, Minn.		
A. J. Buck, Tacoma, Wash.		
E. E. Clothier, Malden, Wash.		
H. R. Drum, Mitchell, S. D.		
L. D. Hadwen, Chicago, Ill.		
F. E. King, Minneapolis, Minn.		
N. H. LaFountain, Chicago, Ill.		
C. F. Loweth, Chicago, Ill.		
T. E. McFadden, Cedar Falls, Wash.		
E. S. Meloy, Chicago.		
Edw. Murray, Miles City, Mont.		
J. F. Pinson, Seattle, Wash.		
William Ross, Milbank, S. D.		
C. F. Urbutt, Chicago, Ill.		
Fred E. Weise, Chicago, Ill.		
A. A. Wolf, Milwaukee, Wis.		
William E. Wood, Chicago, Ill.		
A. Yappen, Chicago, Ill.		
Chicago, Rock Island & Pacific Ry.,	7	7,847
McClellan Bishop, El Reno, Okla.		
S. T. Corey, Chicago, Ill.		
C. H. Eggers, Little Rock, Ark.		
E. R. Floren, Rock Island, Ill.		
Guy Gordon, Little Rock, Ark.		
R. C. Sattley, Chicago.		
I. L. Simmons, Chicago, Ill.		
Chicago, St. Paul, Minneapolis & Omaha Ry.,	5	1,750
J. D. Moen, Boone, Ia.		
A. G. Rask, Altoona, Wis.		
H. Rettinghouse, St. Paul, Minn.		
Aug. Ruge, Mankato, Minn.		
Chas. Sedmoradsky, Altoona, Wis.		
Chicago, Terre Haute & Southeastern Ry.	2	351
J. Dupree, Crete, Ill.		
J. O. Jewell, Terre Haute, Ind.		
Cincinnati, New Orleans & Texas Pacific Ry.	1	338
F. J. Conn, Lexington, Ky.		
Cincinnati Northern R. R.	1	236
J. M. Wilkinson, Van Wert, O.		
Colorado & Southern Ry.	4	1,250
R. W. Beeson, Trinidad, Colo.		
C. W. Fellows, Denver, Colo.		
Harry James, Denver, Colo.		
A. W. Pauba, Denver, Colo.		
Colorado Midland Ry.	1	338
J. Guretzky, Colorado City, Colo.		
Columbia, Newberry & Laurens R. R.	1	75
A. P. Rice, Columbia, S. C.		
Concho, San Saba & Llano Valley R. R.	1	61
K. S. Hull, Temple, Tex.		
Copper Range R. R.	1	150
A. Giesing, Houghton, Mich.		

Name of Road and Membership.	Members.	Mileage
Corvallis & Eastern R. R.,	2	142
W. E. Burns, Albany, Ore.		
F. M. Siefer, Portland, Ore.		
Delaware, Lackawanna & Western R. R.,	7	985
F. J. Arnold, Scranton, Pa.		
G. E. Boyd, Buffalo, N. Y.		
E. Cahill, Binghamton, N. Y.		
C. G. Connolly, Scranton, N. Y.		
A. McQueen, Binghamton, N. Y.		
J. E. Ranney, Buffalo, N. Y.		
Jas. Skeoch, Dunmore, Pa.		
Denver & Rio Grande R. R.	6	2,598
G. W. Kinney, Salt Lake City.		
A. Ridgway, Denver, Colo.		
A. C. Snyder, Salt Lake City.		
H. Taylor, Alamosa, Colo.		
C. S. Thompson, Denver, Colo.		
Jas. Vaughan, Salida, Colo.		
Duluth & Iron Range R. R.	2	197
W. A. Clark, Duluth, Minn.		
B. T. McIver, Two Harbors, Minn.		
Duluth, Missabe & Northern Ry.,	2	356
C. F. Baluss, Duluth, Minn.		
W. A. McGonagle, Duluth, Minn.		
Elgin, Joliet & Eastern Ry.	3	770
G. H. Jennings, Joliet, Ill.		
A. Montzheimer, Joliet, Ill.		
C. Thompson, Joliet, Ill.		
Erie R. R. (and Chicago & Erie)	7	2,665
O. F. Barnes, Jersey City, N. J.		
W. O. Eggleston, Huntington, Ind.		
A. J. Horth, Meadville, Pa.		
F. A. Knapp, Jersey City, N. J.		
W. H. Matthews, Hornell, N. Y.		
Neil McLean, Huntington, Ind.		
W. H. Wilkinson, Elmira, N. Y.		
Florida East Coast Ry.	1	708
E. K. Barrett, St. Augustine, Fla.		
Fort Smith & Western R. R.	1	217
B. F. Beckman, Ft. Smith, Ark.		
Fort Worth & Denver City Ry.	1	454
J. M. Mann, Ft. Worth, Tex.		
Galveston, Houston & Henderson R. R.,	1	50
F. W. Bailey, Galveston, Tex.		
Georgia & Florida Ry.	1	325
W. A. Swallow, Augusta, Ga.		
Grand Rapids & Indiana Ry.	2	592
W. S. McKeel, Grand Rapids, Mich.		
H. M. Large, Ft. Wayne, Ind.		
Grand Trunk Ry. System,	17	4,765
W. Cayley, Stratford, Ont.		
J. B. Gaut, Chicago, Ill.		

Name of Road and Membership.	Members.	Mileage
Grand Trunk Ry. System. Continued.		
J. C. Gokey, Richmond, Que.		
J. Henderson, St. Thomas, Ont.		
J. H. Johnston, Montreal, Que.		
G. C. McCue, Ottawa, Ont.		
J. McMahon, Bellville, Ont.		
H. W. Meyer, Montreal, Que.		
George A. Mitchell, Toronto, Ont.		
F. P. Sisson, Detroit, Mich.		
Jos. Spencer, Stratford, Ont.		
H. B. Stuart, Montreal, Que.		
H. C. Swartz, St. Thomas, Ont.		
W. H. Tichbourne, London, Ont.		
W. J. Tyers, Ottawa, Ont.		
C. F. Warcup, St. Thomas, Ont.		
J. Wilson, Hamilton, Ont.		
Grand Trunk Pacific Ry.	1	3,627
L. H. Wheaton, Dartmouth, N. S.		
Great Northern R. R.,	1	7,748
J. A. Bohland, St. Paul, Minn.		
Gulf, Colorado and Santa Fé Ry.	4	1,603
E. C. George, Beaumont, Tex.		
K. S. Hull, Temple, Tex.		
W. G. Massenburg, Beaumont, Tex.		
W. W. Wilson, Galveston, Tex.		
Hampshire Southern R. R.	1	38
W. Trapnell, Romney, W. Va.		
Illinois Central R. R.	13	4,755
P. Aagaard, Chicago, Ill.		
F. O. Draper, Chicago, Ill.		
C. Ettinger, Chicago, Ill.		
C. R. Knowles, Chicago, Ill.		
R. J. McKee, Freeport, Ill.		
Samuel P. Munson, Mattoon, Ill.		
W. L. Ratliff, Chicago, Ill.		
William Reid, Grenada, Miss.		
M. A. Smith, New Orleans, La.		
O. M. Suter, Chicago, Ill.		
F. L. Thompson, Chicago, Ill.		
J. E. Travis, Chicago, Ill.		
E. F. Wise (retired), Waterloo, Ia.		
Illinois Traction System	1	420
G. A. Wright, Decatur, Ill.		
Intercolonial Ry.,	3	1,468
Hugh Jardine, Moncton, N. B		
W. B. MacKenzie, Moncton, N. B.		
A. C. Selig, Moncton, N. B.		
International & Great Northern Ry.	1	1,106
H. M. Jack, Palestine, Tex.		
Kansas City, Clinton & Springfield Ry.	1	155
J. B. Browne, Clinton, Mo.		
Kansas City Southern Ry.,	3	762
J. J. Casey, Texarkana, Tex.		
C. E. Johnston, Kansas City, Mo.		
J. J. Taylor, Texarkana, Tex.		

Name of Road and Membership.	Members.	Mileage
Lake Erie & Western R. R.,	4	882
T. O. Andrews, Tipton, Ind.		
R. M. Bowman, Indianapolis, Ind.		
P. P. Lawrence, Tipton, Ind.		
J. N. Penwell, Tipton, Ind.		
Lake Shore & Michigan Southern Ry.	4	1,863
Willard Beahan, Cleveland, O.		
Philip O'Neill, Adrian, Mich.		
R. H. Reid, Cleveland, O.		
J. L. Soisson, Norwalk, O.		
Lake Superior & Ishpeming Ry., Munising Ry., and Marquette & S. E. Ry.	2	160
August Anderson, Marquette, Mich.		
Roscoe C. Young, Marquette, Mich.		
Lehigh & Hudson River Railway	1	96
J. E. Barrett, Warwick, N. Y.		
Lehigh Valley R. R.,	9	1,444
E. B. Ashby, New York City.		
Peter Hofecker, Auburn, N. Y.		
J. W. Holcomb, Buffalo, N. Y.		
Judson Joslin, Auburn, N. Y.		
A. E. Kemp, Hazleton, Pa.		
A. L. Reynolds, New York City.		
F. E. Schall, South Bethlehem, Pa.		
L. W. Swan, Easton, Pa.		
E. R. Wenner, Ashley, Pa.		
Long Island R. R.	4	392
W. F. O'Connor, Flushing, N. Y.		
Chas. Wehlen, Jamaica, N. Y.		
W. Wicks, Amityville, N. Y.		
C. W. Wright, Jamaica, N. Y.		
Louisiana & Arkansas Ry.	1	255
W. H. Vance, Stamps, Ark.		
Louisville & Nashville R. R. (and Nash. Term. Co.)	11	4,923
J. M. Bibb, Birmingham, Ala.		
A. J. Catchot, Ocean Springs, Miss.		
R. O. Elliott, Nashville, Tenn.		
H. R. Hill, Birmingham, Ala.		
Floyd Ingram, Erin, Tenn.		
J. W. Little, Birmingham, Ala.		
A. B. McVay, Evansville, Ind.		
C. M. Roy, Birmingham, Ala.		
Wm. Sheley, Evansville, Ind.		
H. Stamler, Paris, Ky.		
W. G. Stewart, Nashville, Tenn.		
Maine Central R. R.	1	1,206
P. N. Watson, Brunswick, Me.		
Michigan Central R. R.	3	1,817
S. D. Bailey, Detroit, Mich.		
Thomas Hall, St. Thomas, Ont.		
Henry A. Horning, Jackson, Mich.		

Name of Road and Membership.	Members.	Mileage
Minneapolis & St. Louis R. R.	2	1,586
Ed. Gagnon, Minneapolis, Minn.		
G. S. Kibbey, Minneapolis, Minn.		
Minneapolis, St. Paul & Sault Ste. Marie Ry.	2	4,020
G. A. Manthey, Minneapolis, Minn.		
P. Swenson, Minneapolis, Minn.		
Miss. River & Bonne Terre Ry.	1	64
C. H. Fake, Bonne Terre, Mo.		
Missouri & North Arkansas Ry., ...	1	365
R. Wagner, Harrison, Ark.		
Missouri, Kansas & Texas Ry.	1	3,073
A. S. Clopton, Parsons, Kans.		
Missouri Pacific Ry. System (including St. Louis, Iron Mountain & Southern Ry.)	24	7,284
E. E. Allard, St. Louis, Mo.		
Robert J. Bruce, St. Louis, Mo.		
W. L. Burnett, Eudora, Ark.		
L. J. Byrd, Dermott, Ark.		
H. R. DeWitt, Little Rock, Ark.		
A. H. Ferdina, St. Louis, Mo.		
C. Gnadt, Poplar Bluff, Mo.		
W. A. Guire, Lake Providence, La.		
Lon Graves, Dermott, Ark.		
J. C. Hargrove, McGehee, Ark.		
E. H. Harvey, Montrose, Ark.		
W. Hausgen, Sedalia, Mo.		
W. J. Lacy, Poplar Bluff, Mo.		
C. W. Lamb, Pine Bluff, Ark.		
G. W. Land, McGehee, Ark.		
A. D. May, Little Rock, Ark.		
C. E. Redmond, Van Buren, Ark.		
J. V. Reynolds, Dermott, Ark.		
C. E. Smith, St. Louis, Mo.		
Wm. Sullivan, Kansas City, Mo.		
F. W. Tanner, St. Louis, Mo.		
L. J. Wackerle, Osawatomie, Kans.		
A. L. Waits, St. Louis, Mo.		
C. H. Walther, Poplar Bluff, Mo.		
Nashville, Chattanooga & St. Louis Ry.	1	1,230
I. O. Walker, Paducah, Ky.		
National Rys. of Mexico	1	6,177
Hans Bentele, Mexico City, Mex.		
New South Wales Government Rys., ...	1	3,967
James Fraser, Sydney, N. S. W.		
New York Central & Hudson River R. R.	12	2,829
J. K. Bonner, Rochester, N. Y.		
U. S. Hitesman, New York City.		
G. J. Klumpp, Rochester, N. Y.		
R. P. Mills, New York City.		
Kemper Peabody, N. Y. City.		
W. A. Pettis, Rochester, N. Y.		
E. J. Rykenboer, Rochester, N. Y.		
S. A. Seely, Watertown, N. Y.		

Name of Road and Membership.	Members.	Mileage
New York Central & Hudson River R. R. Continued.		
W. F. Steffens, New York City.		
E. R. Tattershall, Malone, N. Y.		
H. C. Thompson, Weehawken, N. J.		
E. E. Wilson, New York City.		
New York, New Haven & Hartford R. R.,	11	2,007
Grosvenor Aldrich, Boston, Mass.		
J. S. Browne, Providence, R. I.		
H. H. Kinzie, Taunton, Mass.		
Wm. H. Moore, New Haven, Conn.		
B. P. Phillips, Willimantic, Conn.		
L. H. Porter (retired), Andover, Conn.		
George A. Rodman, New Haven, Conn.		
George T. Sampson, Boston, Mass.		
W. B. Schuessler, Waterbury, Conn.		
D. W. Sharpe, New Haven, Conn.		
J. B. Sheldon, Providence, R. I.		
New York, Ontario & Western R. R.	1	494
J. H. Nuelle, Middletown, N. Y.		
New Zealand Government Rys.	2	2,717
C. H. Biss, Christchurch, N. Z.		
George A. Troup, Wellington, New Zealand.		
Northern Pacific Ry.,	4	6,313
James Hartley, Staples, Minn.		
F. Ingalls, Jamestown, N. D.		
C. S. McCully, Jamestown, N. D.		
J. C. Taylor, Glendive, Mont.		
North Western Govt. Rys. (India)	1	4,431
D. M. Cookson, Kalaw, Burma, India.		
Northwestern Pacific R. R.,	1	469
A. A. Robertson, San Rafael, Cal.		
Oregon Short Line R. R.,	12	2,120
J. F. Cullen, Pocatello, Idaho.		
W. C. Dale, Pocatello, Idaho.		
I. A. Draper, Pocatello, Idaho.		
A. H. King, Pocatello, Idaho.		
C. T. Musgrave, Idaho Falls, Idaho.		
R. Newton, Pocatello, Idaho.		
P. E. Parsons, Salt Lake City, Utah.		
S. J. Powell, Ogden, Utah.		
A. W. Robinson, Salt Lake City, Utah.		
R. B. Robinson, Salt Lake City, Utah.		
A. R. Stevens, Pocatello, Idaho.		
D. T. Wells, Salt Lake City, Utah.		
Pacific Electric Ry.,	2	987
Alf Brown, Los Angeles.		
D. E. Plank, Los Angeles, Cal.		
Pennsylvania Lines West of Pittsburg,	9	3,098
Samuel C. Bowers, Steubenville, O.		
Stanton Bowers, Bradford, O.		
B. F. Gehr, Richmond, Ind.		
A. F. Miller, Chicago, Ill.		
D. G. Musser, Wellsville, O.		

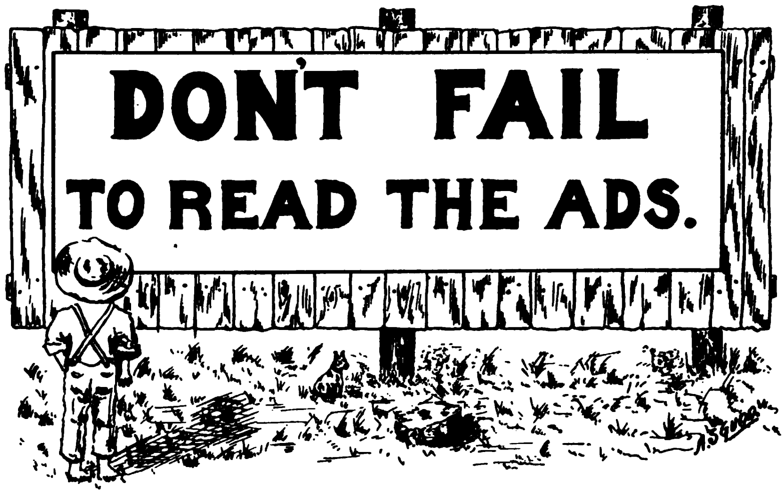
Name of Road and Membership.	Members.	Mileage
Pennsylvania Lines West of Pittsburgh. Continued.		
H. H. Pollock, Carnegie, Pa.		
W. F. Rankin, Cambridge, O.		
J. Wallenfelsz, Cambridge, O.		
D. C. Zook, Fort Wayne, Ind.		
Pennsylvania R. R.,	5	5,304
M. M. Barton, West Philadelphia, Pa.		
Richard G. Develin, Philadelphia, Pa.		
H. R. Leonard, Philadelphia, Pa.		
Robert McKibbon, Altoona, Pa.		
A. W. Reynolds, New York City.		
Pere Marquette R. R.	8	2,336
J. D. Black, Saginaw, Mich.		
Edw. Guild, Grand Rapids, Mich.		
G. E. Hanks (retired), East Saginaw, Mich.		
A. L. McCloy, Reese, Mich.		
A. McNab, Holland, Mich.		
John Robinson, Grand Rapids, Mich.		
J. E. Toohey, Grand Rapids, Mich.		
J. P. Wood, Saginaw, Mich.		
Philadelphia & Reading Ry.,	3	1,481
Amos H. Beard, Reading, Pa.		
E. G. Storck, Philadelphia, Pa.		
E. E. Templin, Pottsville, Pa.		
Pittsburgh & Lake Erie R. R.	2	215
D. L. McKee, McKee's Rocks, Pa.		
G. H. Soles, Pittsburgh, Pa.		
Queen & Crescent Route	1	509
E. L. Loftin, Vicksburg, Miss.		
San Antonio & Aransas Pass Ry.,	2	724
W. B. Harris, Yoakum, Tex.		
J. D. Lacy, Morgan City, La.		
San Pedro, Los Angeles & Salt Lake R. R.	4	1,075
F. M. Bigelow, Salt Lake City, Utah.		
R. R. Bishop, Salt Lake City, Utah.		
W. C. Frazier, Los Angeles, Cal.		
D. W. Scannell, Salt Lake City, Utah.		
Seaboard Air Line Ry.,	4	3,093
B. B. Christy, Tallahassee, Fla.		
W. J. Gooding, Jr., Jacksonville, Fla.		
J. C. Nelson, Norfolk, Va.		
J. L. Winter, Waldo, Fla.		
St. Joseph & Grand Island Ry.	2	319
O. H. Andrews, St. Joseph, Mo.		
Wm. Carmichael, St. Joseph, Mo.		
St. Louis & San Francisco R. R.	1	4,740
F. G. Jonah, St. Louis, Mo.		
St. Louis Southwestern Ry.	2	1,451
J. S. Berry, St. Louis, Mo.		
Wm. Quinn, Tyler, Tex.		

Name of Road and Membership.	Members.	Mileage
Southern Ry.,	13	7,036
D. A. Ballenger, Greenville, S. C.		
J. H. Blackwell, Columbia, S. C.		
R. E. Connor, Columbia, S. C.		
J. R. Fowlkes, Columbia, S. C.		
N. L. Hall, Greensboro, N. C.		
Joseph A. Killian, Jr., Charlotte, N. C.		
J. S. Lemond, Charlotte, N. C.		
C. A. Redinger, Knoxville, Tenn.		
T. E. Sharpe, Greenville, S. C.		
J. B. Teaford, Louisville, Ky.		
G. W. Welker, Alexandria, Va.		
A. A. Wells, Winston-Salem, N. C.		
G. W. White, Charlotte, N. C.		
Southern New England Ry.,	2	85
J. E. Cole, Providence, R. I.		
A. Larsen, Melville, Mass.		
Southern Pacific Company,	65	6,453
H. L. Archbold, Los Angeles, Cal.		
C. J. Astrue, San Francisco, Cal.		
T. W. Bratten, West Oakland, Cal.		
H. Bulger, Oakland Pier, Cal.		
W. H. Burgess, Stockton, Cal.		
D. Burke, Tucson, Ariz.		
F. L. Burkhalter, Portland, Ore.		
W E. Burns, Portland, Ore.		
J. T. Caldwell, Bakersfield, Cal.		
J. H. Clark, Los Angeles, Cal.		
W. S. Corbin, Los Angeles, Cal.		
G. S. Crites, Tucson, Ariz.		
D. M. Crosman, Los Angles, Cal.		
Geo. Dickson, Oakland, Cal.		
R. M. Drake, San Francisco, Cal.		
G. A. Easton, West Oakland, Cal.		
B. F. Ferris, Los Angeles, Cal.		
J. F. Fisher, Sacramento, Cal.		
M. Fisher, Ogden, Utah.		
A. Fraser, Bakersfield, Cal.		
Neil Fraser, Mayfield, Cal.		
P. Fritz, Los Angeles, Cal.		
W. Gaskin, Los Angeles, Cal.		
Ira Gentis, Oakland, Cal.		
J. A. Given, Sacramento, Cal.		
Jas. Gratto, Los Angeles, Cal.		
C. F. Green, Sacramento, Cal.		
P. Giusto, San Francisco, Cal.		
H. A. Hampton, Portland, Ore.		
Robt. Hansen, West Oakland, Cal.		
W. C. Harmon, Bakersfield, Cal.		
J. M. Hinchee, Los Angeles, Cal.		
J. A. Hutchens, Ogden, Utah.		
C. A. Jensen, Los Angeles, Cal.		
H. Lodge, San Francisco, Cal.		
C. W. McCandless, Ventura, Cal.		
W. H. McCoy, Dunsmuir, Cal.		
D. McGee, Sacramento, Cal.		
A. M. McLeod, Oakland, Cal.		
J. B. Malloy, San Francisco, Cal.		

Name of Road and Membership.	Members.	Mileage
Southern Pacific Company. Continued.		
J. D. Mathews, Tucson, Ariz.		
F. D. Mattos, W. Oakland, Cal.		
M. J. Mayer, San Francisco, Cal.		
A. T. Mercier, Los Angeles, Cal.		
E. C. Morrison, San Francisco, Cal.		
J. J. Murphy, Oakland, Cal.		
P. N. Nelson, San Francisco, Cal.		
Harry Pollard, San Francisco, Cal.		
Homer Pollard, West Oakland, Cal.		
Geo. W. Rear, San Francisco, Cal.		
J. S. Replogle, Oakland, Cal.		
D. B. Rich, Stockton, Cal.		
D. T. Rintoul, Bakersfield, Cal.		
A. L. Robinson, Stockton, Cal.		
Norman Rose, Portland, Ore.		
W. M. Rose, Sacramento, Cal.		
Niles Searls, San Francisco, Cal.		
G. W. Sedwell, Bakersfield, Cal.		
W. W. Sheldon, Oakland, Cal.		
C. W. Smith, Portland, Ore.		
Thos. Tretheway, Stockton, Cal.		
E. J. Vincent, Los Angeles, Cal.		
A. Weldon, Bakersfield, Cal.		
C. A. Wester, Dunsmuir, Cal.		
M. M. Wilson, Los Angeles, Cal.		
South Manchuria Ry.,	1	10,000
Y. Maruyama, Dairen, Japan.		
Tennessee Central R. R.	1	393
E. M. Carter, Nashville, Tenn.		
Texas & Pacific Ry.	1	1,885
E. Loughery, Marshall, Tex.		
Texas Midland R. R.	1	125
E. H. R. Green, Terrell, Tex.		
Thousand Islands Ry.	1	18
H. A. Cooper, Gananoque, Ont.		
Toledo, Peoria & Western Ry.	1	248
J. H. Markley, Peoria, Ill.		
Toledo Railways & Light Co.,	1	110
A. Swartz, Toledo, O.		
Trinity & Brazos Valley Ry.	1	466
B. M. Hudson, Teague, Tex.		
Union Pacific R. R.,	1	3,574
J. Parks, Denver, Colo.		
Virginian Ry.,	1	444
P. W. Cahill, Roanoke, Va.		
Wabash R. R.	2	2,514
A. O. Cunningham, St. Louis, Mo.		
William S. Danes, Peru, Ind.		
Washington Terminal Co.,	1	53
W. M. Cardwell, Washington, D. C.		

Name of Road and Membership.	Members.	Mileage
Wellington & Manawata Ry. (New Zealand)	1	84
Arthur Williams, Wellington, New Zealand.		
Western Australia Government Rys.	1	1,943
E. S. Hume, Midland Jct., Western Australia.		
Western Pacific Ry.	2	934
M. R. Krutsinger, Sacramento, Cal.		
T. J. Stuart, Elko, Nev.		
Wheeling & Lake Erie R. R.	3	496
Wm. Mahan, Canton, O.		
W. L. Rohbock, Cleveland, O.		
E. U. Smith, Cleveland, O.		
Yazoo & Miss. Valley R. R.	2	1,370
D. H. Holdridge, Vicksburg, Miss.		
W. Shropshire, Greenville, Miss.		
Total Members and Mileage, ...	508	253,221
Members not with Railroads, ...	78	
Total Membership, ...	588	

INDEX TO ADVERTISEMENTS


DON'T FAIL
TO READ THE ADS.

The Controlling Altitude Valves

automatically maintain a uniform stage of water in Standpipes, Reservoirs or Tanks. No overflow in case of fire pressure. Valves closed by water or electricity

Float Valves ***Standpipe Valves***
Electro-Hydraulic Valves

Automatic Valves

For Steam and Water Service

"Automatic Float Valves"

"Angle or Globe"

Valves up to 24 inches

The Golden-Anderson Float Valves

are instantly adjusted to operate Quickly or Slowly as desired. Indestructible. They are Absolutely the Only Satisfactory Float Valves Known for High or Low Pressure.

Automatic Cushioned Water Pressure Regulating Valves

We make the largest, heaviest and most correct mechanically constructed and operated line of Automatic Valves for high or low pressure steam and water service in the U. S.

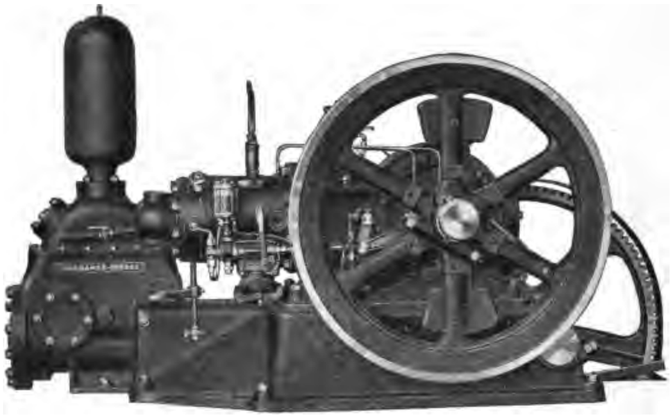
Golden-Anderson Valve Specialty Co.

1207 Fulton Bldg. Pittsburgh, Pa.

A High-Grade Engine

to operate on

Low Grade Oils



Combined Oil Engine and Pump

---Not a hot-ball engine.
---Not electrically ignited.
---Runs successfully on an extremely wide range of liquid fuels.
---Cost of operation and maintenance is very low.

Fairbanks, Morse & Co.

Chicago **New York** **San Francisco**

467-42B

One Roofing Used Twice

After fighting smoke, burning cinders and storm for seven years, the roofing shown above on the old Wells Street Station of the C. & N. W. R. R. in Chicago, was rolled up and used to re-roof several suburban stations. It is

NEPONSET PAROID ROOFING

This hard wear has not taken the life out of the roofing, and it is now giving perfect service in its new locations. A good life insurance risk is the man who lives beyond the average time—longer than he is *expected* to live. A good roofing is one that lasts *longer* than is necessary. That's what NEPONSET Paroid does. An ideal roofing for factories, storehouses and farm buildings.

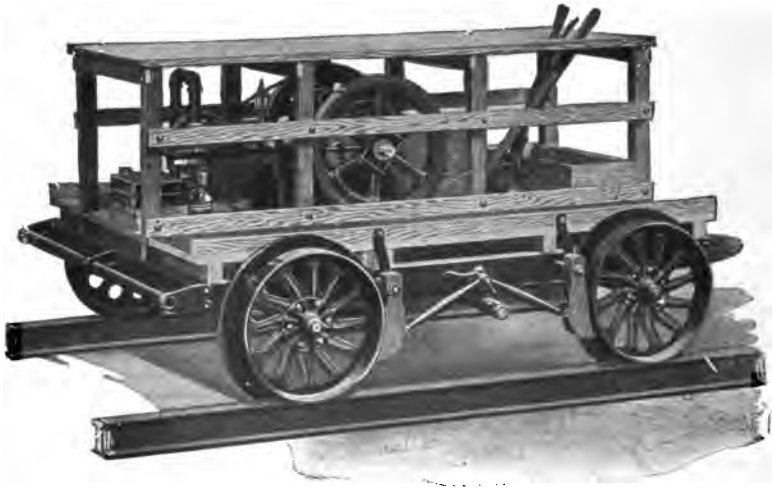
BIRD & SON 515 Neponset Street
E. Walpole, Mass.

New York Chicago Washington San Francisco
Canadian Plant: Hamilton, Ont.
Established 1795

NEPONSET
Proslate Roofing
makes a handsome red or green roof for houses

HUSKY JERRY BOY MOTOR CARS

2 1-4 and 4 H. P.



MEANS

QUICK transportation of men and material.
SAVING of energy for direct track work.
LOW FIRST cost—small maintenance expense.
POWERFUL four-cycle reversible engine.
ABSOLUTE reliability at all times.

The service record of the Jerry Boy Motor Cars on a hundred railroads in forty-two states and Canada challenges the most careful investigation by Bridge and Building and Maintenance of Way Officials. Ask for booklet.

Complete Outfit or Engine Alone

ASSOCIATED MANUFACTURERS CO.

WATERLOO, IOWA

HEAR WHAT HE SAYS—

SOME LOAD.

I have had occasion to haul 73 ties on push car and three men and tools, and made a speed of 16 miles per hour. Everybody says my engine beats anything they ever saw. I cannot say too much for the Jerry Boy. Mind you, this Jerry Boy is only 2¼ horse power, but I have pulled six 33-foot 80 lb. rails, also 12 men—total 5,280 lbs. In the year I have had the engine it has traveled about 6,322 miles at a repair expense of 45c.

SAVES AN HOUR A DAY.

I have one of those Jerry Boy engines, made by the Associated Manufacturing Co., Waterloo, Iowa. The engine cost $56.00 and the freight. I am receiving the best kind of service from it, it has never been out of fix and it saves an hour's time every day if I am working five or six miles away from the tool house. I must say it is a good thing and I wish all foremen had them as they save a lot of time.

STUCK ON THE JERRY BOY.

I took my Roadmaster on an 86 mile trip one day last week and he said that he never saw an engine run so nice as my Jerry Boy. He is stuck on my car. Jerry Boy Engine ran as long as we wanted it to and was always ready to start when we were ready.

OUT AND OUT FOR JERRY BOY.

I am an out and out Jerry Boy advocate, as I have fourteen of them on my division out of a possible nineteen sections, and I think others will fill out in the spring. I have had a chance to see most all cars, and for simplicity and sure go—I prefer the Jerry Boy every time.

RIGHT ON THE JOB.

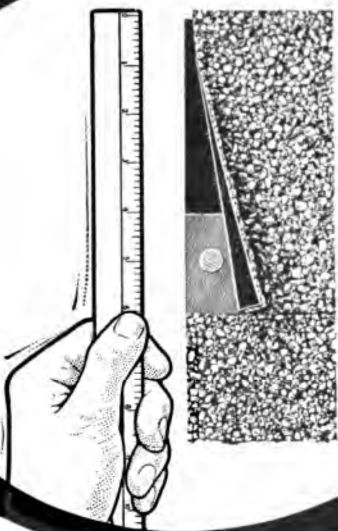
I have found the Jerry Boy engine to be very successful and the best on the road. My Roadmaster has a ——— engine and I had to push him up the hill the other day. I had a little trouble with the engine in the first tests, but now as I have learned it thoroughly there is no more trouble. While this Jerry Boy engine is not supposed to make more than 15 miles per hour, it can do it with ten men and tools.

ORIGINAL LETTERS ON FILE

ASSOCIATED MANUFACTURERS CO.

WATERLOO, IOWA

SIX INCHES of ASPHALT CEMENT-WELDED JOINT



Instead of the ordinary, clumsy joint, easily broken and with all nail-heads showing, you can have an absolutely tight, six-inch weld, without a nail-hole through the roof, if you use

Write today for free book, "The Requirements of a GOOD Roof." It tells in detail why Security Wide-Weld Asphalt Roofing meets these requirements, and how easy it is to weld the patented 6-inch joint.

SECURITY WIDE-WELD ASPHALT ROOFING

The National Roofing Co.

Manufacturers of Asphalt Roofing and Paint

Address communications to 217 Filmore Ave. Tonawanda, N. Y.

Chicago Bridge & Iron Works

Standard Hemispherical
Bottom Steel Tank

ENGINEERS, MANUFACTURERS, CONTRACTORS

Design—Manufacture—Construct

Water Tanks, Standpipes, Oil Tanks, Coal Chutes, Gas Holders, Bridges, Turntables, Buildings, Structural Steel

Metal Structures for Every Purpose

Write us for plans, specifications and prices
Illustrated catalogue mailed upon request

Eight Track Rolling Lift Bridge

OFFICES

Throop and 105th Streets
Chicago

Praetorian Building
Dallas, Texas

30 Church Street
New York

Greenville
Pennsylvania

SHOPS

Chicago, Ill.
Greenville, Pa.

Patented Elliptical Bottom Steel Railway
Tank Replacing Wooden Structure

All Steel Coaling Station

Use DICKINSON

CAST IRON CHIMNEYS

Durable, Cheap and Fireproof

We also make Smoke Jacks, Ventilators and C. I. Buildings

Paul Dickinson, *Inc.* 3346 SO. ARTESIAN AVE. CHICAGO

KELLY-DERBY CO., Inc.

349 Peoples Gas Building

Chicago, Ill.

Headquarters for

RAILWAY SUPPLIES KCD PEOPLES GAS BLDG. CHICAGO

Pumps
Power Heads

Engines
Motors

Well Cylinders
Well Strainers

Steel Trucks
Generators

Feed Water Heaters and Purifiers, Hose, Belting
Packing, Diaphragms, Pump Valves
Dredging Sleeves, Cushions

¶ They make the best covering obtainable for Railroad Buildings. Fire-proof, storm-proof, attractive in appearance and durable. Made of tinplate and painted red or green or galvanized by a hand dipping process; also stamped from special tight coated galvanized sheets.

¶ Send for catalog "Concerning That Roof," samples and prices before deciding as to the roofing for that new station or warehouse.

CORTRIGHT METAL ROOFING COMPANY

Philadelphia, Pa. Chicago, Ill.

A REAL Coaling Station

L. S. & M. S. Ry.
TOLEDO, Ohio

"HUNT" Equipped

Specialists for 40 years in the manufacture of machinery for economical handling of bulk material

Catalog 1129 will interest you

C. W. HUNT CO., Inc., West New Brighton, N. Y., U. S. A.

45 Broadway, New York City Fisher Bldg., Chicago Evans Bldg., Washington, D. C.

Protection Brand Roofing

Mineral Surfaced

MADE from carefully selected felts. Saturated with high grade asphalt. Surfaced with sand or gravel. Needs no painting. Has a 6 inch unsurfaced lap through which the nails are driven and to which the overlapping sheet is welded, making joints absolutely tight.

An excellent permanent roofing which can be easily and quickly laid . ˙. . ˙.

ASPHALT READY ROOFING COMPANY

Manufacturers of Roofing Materials, Asphalt Shingles, etc.

9 Church Street **New York, N. Y.**

An Industrial Works Convertible Crane Pile Driver

combines the functions, the safety, and the labor saving abilities of a locomotive crane and a pile driver. As a pile driver it will drive piles at either side or end of the car. It has a complete battering arrangement. The leader truss is easily removed and regular boom substituted for locomotive crane service.

INDUSTRIAL WORKS, BAY CITY, MICH.

Locomotive and Wrecking Cranes, 5 to 150 tons capacity, Pile Drivers, Transfer Tables Pillar Cranes, Railsaws, Transfer Cranes, Steam Hammers, Grab Buckets